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USER'S MANUAL FOR THE SCREEN PROGRAM

Report to
Office of the Chief of Naval Operations
(Op-961)
May 1, 1980

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Under Contract No. N00014-76-C-0811

by

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ABSTRACT

This report explains how to use the SCREEN program, a computer program designed to evaluate acoustic detection and localization performance of an anti-submarine protective force about a Naval task force or other shipping. A companion report documenting the theory of the SCREEN program supplements this report. The measures used to evaluate the SCREEN performance are: cumulative detection probability against specific target approach tracks and cumulative localization performance against these same tracks. In addition to cumulative measures, "snapshot" detection and localization measures are also computed, which provide an indication of the detection and localization coverage of the defensive screen at a specified time.

The SCREEN program operates on data files which contain moderately detailed descriptions of the acoustic environment (propagation, noise, etc.), the sensor parameters and tactics, and the screen penetrator (target) parameters and tactics. These descriptions include both deterministic and stochastic parameters. The data file contents can be created, altered, and displayed by the user under program control. Once the data files have been created, subsequent use of SCREEN is straightforward and concise, involving user-selectable program options and machine prompts for input.

The underlying detection process is a modified (λ, σ)-jump process. The target process is a modified Integrated Ornstein-Uhlenbeck (IOU) process. The basic localization algorithm is an "Information Flow" Kalman filter. Bayesian updating techniques are used to evaluate search effort, along lines similar to techniques found in computer assisted search programs which are currently being implemented in the Fleet.

PREFACE

This is a report to the Chief of Naval Operations (Op-961) under Contract No. N00014-76-C-0811, which explains how to use the SCREEN program, a computer program designed to evaluate acoustic detection and localization performance of an anti-submarine protective force or other shipping. This is a companion volume to reference [a], the theory of the SCREEN program.

The theory of SCREEN incorporates the results of several lines of analysis developed largely by this firm over recent years. These lines include cumulative detection probability and other acoustic detection modeling, Kalman filtering and other localization techniques, stochastic target motion models, and the methodology of computer assisted search.

The acoustic detection model is based on algorithms for cumulative detection probability (cdp) involving the (λ, σ)-jump process, that have a long history of development beginning with reference [b] in 1964. A commentary on the validity of this line of model development is found in reference [c]. In reference [a], the theory is extended to the case of a randomly sampled jump process.

Models for target localization and target motion analysis (TMA) also have a long history of development. The SCREEN program uses Kalman filter techniques developed in reference [d], based on the "information flow" approach to the Kalman iteration technique. This work is representative of a number of generically similar approaches to TMA and should provide a reasonable expression of expected localization performance of bearings-only and active sensors. Reference [a] extends the basic Kalman iteration to include correlated observations, which is an important improvement over previous algorithms.

The SCREEN program evaluates screen performance against targets that follow penetration strategies as dictated by various target files created by the SCREEN user. Each target file describes in essence a target diffusion process which is a discrete-time analog of the Integrated Ornstein-Uhlenbeck (IOU) process. The IOU process, and other processes for target motion have received substantial study in recent years.

The methodology of computer-assisted search (CAS) also has a long history, and since the SCREEN program is representative of one line of CAS development, an extended discussion of its development seems merited at this point.

The use of computers in planning search effort goes back to the H-Bomb search off of Palomares, Spain in 1966, and a subsequent extension of the technique in the Scorpion search in 1968. This early methodology was further developed and used in the first real-time computer program for Bayesian search planning, the U. S. Coast Guard CASP program. This has been operational since 1972.

The essential innovative features of the early search programs were the inclusion of target "scenarios" to define prior target distributions and move them through time, and Bayesian updating to show the effects of search effort as an aid in subsequent search planning. These programs are Monte Carlo simulations and have subsequently been developed into a line of standardized CAS programs whose development is sponsored by ONR.

In 1975, as a direct precursor of SCREEN, Dr. T. L. Corwin, then attached to the COMSUBPAC staff, devised an analytic search program (ASP) for use on a desktop calculator. The ASP program utilizes target scenarios, described as stochastic diffusion processes, and evaluates search against them in an analytic fashion. Useful features of the ASP program which are retained in SCREEN include the capability to operate the program in real time and to modify the program to account for positive contact information, remove such contact information, and adjust search tactics in real time for actual, versus planned, operations.

The analytic search methodology of SCREEN is an outgrowth of Corwin's work. Work on SCREEN commenced in 1976 under the initial sponsorship of CAPT W. Mitchell of Op-96. The initial structure was developed by Dr. Bossard and the first working programs were produced in early 1977 with the substantial assistance of Dr. W. H. Barker. The first working program provided only detection performance measures. These were subsequently extended to include localization measures in the summer of 1978.

In mid-1978, the SCREEN program was used for the first time as an important analysis tool in the Submarine Alternatives Study (SAS) which was conducted by CNO (Op-02) at the request of the Secretary of the Navy and led by CAPT James Van Metre. In that study, the SCREEN program has been utilized extensively to analyze alternative U. S. submarine designs in the Anti-Surface Warfare (ASUW) and direct support roles. In addition to this use of SCREEN, it was used in various short analyses by CNO (Op-96) in the winter of 1978-1979. Based on these uses, many improvements have been incorporated into the program and increased confidence in its utility and general model accuracy has been gained.

A number of analysts, in addition to the authors of the present report, were involved in the development and testing of the SCREEN program. The principal additional contributors were: Dr. W. H. Barker (1976-1977), Dr. L. K. Arnold (winter 1977-1978), and Dr. B. E. Scranton (since Fall, 1978). Mr. B. M. McDaniel was extensively involved in programming aspects during this period of time and Mr. R. L. Andersson developed a number of computer "bookkeeping" routines useful to the program. Dr. Scranton was responsible for much of the testing and improvements to SCREEN included during the SAS and Op-96 analyses noted above. Dr. D. P. Kierstead also provided a useful critique of the program algorithms.

We wish to acknowledge the excellent support and cooperation of Op-961 from successively CAPT William Mitchell, USN (ret.), Mr. Robert A. Hallex, and most recently CAPT Raymond Wyatt, USN. Without their continuing support and constructive help, this project would never have achieved the present state of development. We wish to also acknowledge the support of CAPT Van Metre and of Dr. David Stanford of Science Applications, Incorporated, who sponsored the use of the SCREEN program in the recent Submarine Alternatives Study.

CHAPTER I

INTRODUCTION TO SCREEN

This report is a user's manual for the SCREEN program, a tool for analyzing submarine warfare engagements. In this chapter, an overview of the program is given. Chapter II then describes a variety of ways that SCREEN may be used as an analysis aid. Chapter III describes the use of the program option list, assuming that the detailed sensor, environment, and target files exist. Chapter IV treats the data files used in SCREEN: their contents and preparation. Chapters V and VI contain an extended example of the use of SCREEN. Chapter V addresses the problem description and set-up phase. Chapter VI illustrates the use of the analyses options in SCREEN.

The SCREEN program models the acoustic detection and localization performance of a defensive antisubmarine warfare (ASW) screen about a task force or high value shipping unit. It performs this modeling by allowing the user to construct screen formations and test them in different acoustic environments against various target penetration tactics. We believe that the SCREEN program is the most detailed and flexible program of its kind in existence. The remainder of this chapter gives: first, an overview of the intended uses of SCREEN; second, a brief foray into the underlying concepts involved; third, an outline of the program structure; and finally, some historical notes.

SCREEN Applications

The SCREEN program is intended to be a tool for use in analysis of ASW screens. SCREEN performs many of the laborious detailed calculations which should properly be side issues and not the main focus of screen analyses.

In a typical application, the ASW screen modeled consists of one or more high value units (HVUs) surrounded by a configuration of stationary or moving sensors. The screen, together with its protected force, moves through an ocean area along a planned base track (designated PIM = Position and Intended Motion). One or more targets will attempt penetration of the screen following specified planned approaches. After establishing initial conditions, the program steps the engagement in discrete time steps. At any time step, the various inputs can be modified (if desired) and the detection or localization performance can be evaluated.

The SCREEN program is designed to be used either as a study aid (batch computer processing) or 'real time' analysis tool (interactive computer processing). The study mode of operation would typically be used in analyses of alternative SCREEN designs or ASW platform studies. In this mode of operation, all the necessary inputs and sequences of operation are specified in advance and the program proceeds to run in a batch mode without further involvement by the operator.

An example of recent use in the study mode is in the Submarine Alternatives Study, described in reference [e]. The analysis involved two alternative screen formations and three alternative environments. For each of several alternative submarine designs, a variety of penetrating tactics were developed and then played against the established sensor files and environments. Design excursions, such as changes which affect radiated noise characteristics, were easily incorporated by using the various program run options that will be described below. In this analysis, only the detection features of the program were used. One could imagine a similar analysis using both the detection and the localization features of the SCREEN program.

In the 'real time' mode of operation, one imagines a one- or two-sided game in which the sensor screen and targets form the (opposing) sides. In this case, the environment may be assumed fixed. The two sides would begin the game by establishing initial screen sensors for the task force and initial target penetration tactics for the targets. The game could be played one or more time steps at a time. The outcome of the game at each pause of the game would be examined. At each pause in the game, each player would have the option to alter his strategy based on the current information provided by the various analysis options. Then these actions would be evaluated at the next pause. In this mode, the SCREEN program is run interactively on the computer.

SCREEN Performance Measures

The screen performance is expressed by two performance measures, one related to detection and the other to localization. Each of these measures is expressed in turn in two ways: as a short-duration "snapshot" or as a longer duration cumulative performance measure. The snapshot performance measures address questions about short-term performance: "How am I doing now?" or, "How did I do at hour 3?" The cumulative performance measures, as the name implies, state the combined effect of the screen or sensor group evaluated over an extended period of time. Cumulative measures address such questions as: "How well localized will a flank penetrator be by the time he is 60 nautical miles from the HVU?"

Detection of a target by a sensor is assumed to be a stochastic process: that is, it involves both deterministic and random (probablistic) phenomena. A full description of this process is given in Chapter II of reference [a]. In brief, the process is as follows. The signal processed by a sonar is the sum of a mean value determined by the Sonar Equation and a random value which we describe as a (lambda,sigma) jump process, where sigma is the standard deviation of the random component and lambda is the effective rate of independent samples of this random component(number of samples per hour). When the total signal exceeds a "detection threshold," a detection occurs. If the mean signal is high (substantially over the detection threshold), then the detection probability is high. If the mean signal is low, the short-term detection probability is low, but still it is possible to build over time to a significant cumulative probability. The snapshot detection performance concerns the short-term detection probability, and is closely related to the value of mean signal excess. Cumulative detection performance, on the other hand, involves both the mean signal excess taken over the duration of the search and the accumulation of detection opportunities over time.

Not all sensors that have high detection performance are able to localize the contacts accurately. Thus, the SCREEN program has the capability to evaluate localization as well as detection. This localization measure is described in Chapter III of reference [a]. For our present purpose, it is sufficient to state that the measure used relates to the expected localization information found in a Kalman filter solution formed on the target. As with detection, there is a snapshot (short-term) as well as a cumulative measure of localization. The snapshot measure evaluates the mean localization information available in a short span of time. Basically, such localization arises from cross fixes between passive sonars holding contact, an active sonar contact, or combinations of these. The cumulative measure is akin to target motion analysis (TMA). It additionally (indirectly) incorporates such localization data as bearing rates and nonsimultaneous bearings from different platforms.

The Program Structure

In this section, the logical structure of the SCREEN program is explained.

Data files. The SCREEN program gets its input data from three types of data files, together with inputs provided directly by the operator. The three file types are:

(1) an environmental file,

(2) a sensor file, and

(3) one or more target files.

Only one each of the environmental and sensor files may be used at a time, but multiple target files are allowed.

Upon program initialization, the SCREEN program cues the user for file identifications. The specified files that already exist from previous work are accessed, and the user is prompted for the inputs required to create any other files. The contents and preparation of these files is discussed in Chapter IV. If it is desired to alter the file contents, or to access different files during program execution, this is easily done by selecting an appropriate program option.

Program options. After declaring the active files, the program operator is given a choice of program execution options which he can use to direct the subsequent flow of the program. A summary list of these options is given in Table I-1. The options are described in detail in Chapter III. Some of the things that can be done with these options include:

(1) make formatted lists of the input file contents used (LLOSS, LCON, etc.),

(2) compute detection coverage map for a single sensor, a specified group of sensors, or the whole screen (PDSEN or PDSTEP),

(3) compute a target localization coverage map for a group of sensors or the whole screen (PDSTEP),

(4) display a map of the prior target probability distribution, as determined from the target files (MAP,MAPL),

(5) compute and display a map of the estimated posterior target probability distribution after search has been conducted, (MAP,MAPL),

(6) compute the cumulative probability that the screen detected a target at each time step of approach, (CDP,CDPL,MAP,MAPL), and

(7) summarize the screen localization performance at each time step of approach (CDPL,MAPL).

A coverage map superimposes a gridwork over the operating area surrounding the screen or sensor and then computes for each gridpoint the conditional snapshot detection or localization assuming a target is located at that gridpoint. The target files declared during program initialization define equally probable target scenarios. Thus, the target prior is a composite over all of the declared target files.

The detailed description of the various input parameters, the sophistication of the algorithms in use in the SCREEN program, and the multiplicity and complexity of its various output forms make it a useful and flexible program. Unfortunately, this detail requires a substantial amount of computer power and the basic files are tedious to set up initially. However, once the basic files have been established, most of the program's complexity will be transparent to the user and the program can be run with a modest understanding.

TABLE I-I

OPTIONS IN SCREEN

Bookkeeping	COMI	Invoke Command File
	OUTPUT	Declare File for Output
	DONE	Exit Program
File Set-Up	INIT	Load Data Files or Create New Ones
	TSTEP	Alter Current Program Time
	POSIT	Add SPA Contact Data
	BEAR	Add Bearing Contact Data
	MARG	Constrain a Marginal Distribution
List File	LLOSS	List Propagation Loss Curves
	LCON	List Sensor Contours
	LPIM	List PIM and HVU Parameters
	LSEN	List Sensor Parameters
	LTAR	List Target Parameters
Update, Modify Files	ULOSS	Modify Propagation Loss Curves
	UCON	Modify Sensor Contours
	UPIM,UHVU	Modify PIM and HVU Parameters
	USEN	Update Sensor Parameters
	UTAR	Update Target Parameters
Snapshot Evaluation	PDSEN	Display Sensor Coverage
	PDSTEP	Display Group/Screen Coverage
Cumulative Evaluation	CDP	Compute Cumulative Detection Performance
	CDPL	Compute Cumulative Detection and Localization Performance
	MAP	Compute Detection and Display Prior and Posterior Target Distribution
	MAPL	Compute Detection and Localization and Display Prior and Posterior Target Distribution and Localization

Historical Notes

The beginnings of the SCREEN theory can be found in early Computer Assisted Search (CAS) work by Wagner, Associates. In particular, the notion of searching against a target prior distribution which is a composite of target "scenarios" is due to this early effort. See reference [f] for a discussion of these concepts.

An immediate ancestor to SCREEN was a set of interactive programs developed for the Pacific Submarine Force by Dr. T. L. Corwin in 1976. In his original development (see, for example, reference [g]), a computer program was designed for use on a Wang desktop calculator to assist a carrier task force in designing its screen coverage so as to detect opposing screen submarine penetrators. The program was designed to be used in real time and allowed the inclusion of contact information as well as retroactive corrections to sensor parameters and contact data as the problem evolved. Originally designed as a tool to aid in designing direct support submarine patrol areas, the program proved to be generally useful in a number of successful operations.

About a year after Dr. Corwin's original work, Op-961 (CAPT William Mitchell) expressed a desire to design a computer program to evaluate alternative task force screen designs. The objective of this analysis was to allow Op-961 to test proposed new system procurements in the context of a protective screen consisting of a variety of sensors, in order to determine their marginal contribution to the overall capability of naval forces. The program as originally conceived was required to be flexible enough to describe various alternative sensor platforms in sufficient detail to distinguish among various design objectives.

The first programs developed for Op-961, restricted to detection measures, received favorable response when they were demonstrated in 1977. Early in these reviews, CAPT John Underwood, USN (retired) stated that localization information, as well as detection information, should be included. The present version of SCREEN addresses that task and provides both capabilities.

The SCREEN program has been used extensively over the past 15 months in various Navy studies, particularly the Submarine Alternative Study, sponsored by Op-02 and some additional short timeframe analyses by Op-96. The Op-02 work is the most extensive done to date. A summary of the results of that analysis is contained in reference [e].

Current program status. As a result of the recent use of SCREEN, we feel that the detection portion of the program is fairly well checked out. It should be noted, however, that there are literally millions of possible branches during the course of an analysis utilizing SCREEN and that it is physically impossible to explore all of these branches for logical flaws in the program. Thus, while we express confidence in the overall performance in the detection portion of the program, there may remain some pathologies to be corrected. It

is only slightly humorous to note that virtually every time a fresh analyst has been introduced to the program, he has discovered some unexplored branch and usually has unearthed some behavior in the SCREEN program which resulted in program modification.

In contrast to the detection portion of the program, the localization options have received very little use beyond the initial debugging. In the near future, when the localization performance is used in various studies, it can be expected that some changes to the program will be indicated. Until experience is obtained, it is impossible to express the same degree of confidence with respect to the localization portions of the program as has been expressed with regard to the detection portions.

The current program exists as a single large FORTRAN program. Because of the large number of program options available, the unified code occupies a fairly large amount of computer memory and therefore requires a very capable computer to run. It is expected that in the near future the program will be broken into logical units which will be individually executable with more modest memory requirements.

CHAPTER II

THE USES OF SCREEN

In this chapter, the uses of SCREEN are discussed. The first section surveys the types of problems that can be addressed. The next two sections treat the tactical decisions which are necessary to provide a tactical description of the problem to be analyzed. Finally, some overall remarks are made on the possible analyses that can be performed with the SCREEN program.

The Classes of Problems Addressed by SCREEN

The SCREEN program is nominally designed to aid in the analysis of an ASW defensive screen placed about high value shipping. However, the program design lends itself to a broader range of applications.

At one extreme, the SCREEN program can be used to analyze isolated tactical problems. Examples of these are as follows:

(1) One-on-one engagement. A screen consisting of one sensor platform (possibly with several sensors) can be the basis for an analysis of a one-on-one engagement. When a sufficiently short time step is chosen, specific approach/evasion maneuvers can be modeled for both the sensor platform and the target. The Kalman filter target motion analysis built into the localization portion of SCREEN can estimate the refinement to a fire-control solution. Performance in different environments can be analyzed. Use of several sensors simultaneously, including selective use of active sensors, may be examined.

(2) One-on-many engagement. The SCREEN program can assess the performance in detection/localization by a single platform against multiple simultaneous targets

considering the sensitivity to environment, the effect of relative bearings holding contact, etc.

(3) Many-on-one, many-on-many engagements. The SCREEN program can also analyze various tactical engagements among several search platforms against one or several targets including differing degrees of task force communications (possibly requiring interactive rather than batch operation of SCREEN).

(4) Use of reactive screen elements. The SCREEN program can examine an engagement between a reactive screen platform (such as a deck- launched weapon or search platform) and a target. This would require two separate runs of SCREEN: one run to model the general task force screen or the performance of the host platform's search -- which is used to generate the detection and localization opportunities (location and size) for the reactive forces -- and the second run to model the reactive units' performance (redetection and localization). Undoubtedly, the second run would use a much tighter time step and spatial resolution than the first would. This type of analysis would aid in proper placement of reactive forces within a screen.

(5) Placement of screen units and modules. The SCREEN program can help analyze the effects of task force noise, the possibilities for mutual exchange of information, and the placement of localizing reactive forces. A typical example of this analysis is placement of a flanking sonobuoy field, taking into consideration the effect of task force noise interference.

At the opposite extreme, the SCREEN program can assist in analyzing the performance of a task force in an extended scenario. A Hunter-Killer (HUK) Group evaluation may extend over days and include a number of environments. The evaluation of task force transit vulnerability includes different environments which imply different defensive screen configurations and different attack tactics. Such analyses would involve a composite of several separate runs of SCREEN.

Designing a Screen

In this section we will discuss the thought processes that are involved in designing a defensive screen. Any analysis involving the SCREEN program will utilize some thought process in the screen design and perhaps use the SCREEN program to modify the design from time to time.

A task force screen is primarily designed to counter the likely penetration tactics of opposing submarines. The opposition presumably has the mission to attack the high value units in the task force. Possibly, the attack of the escort units themselves is a secondary objective. Success for the target may be measured by penetration to a designated weapon launch region. Success as defined by the screen is to minimize the likelihood of this event.

Before we discuss the question of what measure of effectiveness the screen should use in assessing its performance, we note that a real encounter between a defensive screen and opposing submarines is a two-sided game where each side has partial information about the other side and each side is operating under certain constraints that limit its options. Theoretically, optimal screen design should be a solution to this two-sided game. In practice, however, the solution possibilities are so numerous that no computable solution to the game is possible; the usual procedure is to postulate reasonable tactics, evaluate them, and modify them in search for configurations that yield improved performance. This is an inexact science subject to errors in application.

The smart target. Usually we assume that the penetrating target has some information about the screen composition and that it will attempt to evade screen units to the extent of its knowledge subject to the primary objective of accomplishing its mission. This being the case, the task of the screen designer is to produce a screen which is sufficiently nonporous that the anticipated intelligent target will be unable to exploit gaps in coverage. Such gaps might appear, for example, between an outer screen and an inner screen. The penetrating target could exploit a gap by skirting around the outer units and then passing ahead into an advantageous position. Of course, for each modified screen configuration, a new set of intelligent target penetration tactics is probable. At some point, small changes in tactics produce negligible changes in screen configuration and the user considers the screen to be fixed. It is important to realize, however, that in reality this is a dynamic two-sided problem and that design of an optimal screen against fixed penetrating tactics may result in an optimistic assessment of performance when in fact the penetrators may be able to adapt their tactics. Conversely, the design of optimal penetrator tracks against a fixed screen configuration may result in an optimistic assessment of the penetrator's capability when in fact the task force commander may be able to adjust his screen placements.

Operating constraints. In addition to considering the two-sided

game with the target, the design of a screen must take into account various operating constraints. The most obvious, perhaps, is that the speed of advance dictated by the PIM, which the screen defensive units may be obliged to maintain, may not be optimal for their search functions. We do not wish to discuss the question here, but experience indicates that aircraft carriers do not slow down to give screen units opportunities to search for or attack attackers. Thus, sometimes sensor platforms must engage in sprint and drift or similar search tactics resulting in incomplete or less than optimal coverage of the search area. Sometimes the penetrating target can take advantage of these gaps in coverage, particularly after it detects the noise radiated by the search platform during the sprint phase.

Other constraints on the screen design include collateral duties of some of the search units, particularly the case of surface platforms in the inner screen about an aircraft carrier (CV). Such screen units may have to perform point defense against cruise missile attacks, retrieve downed aircraft and pilots lost at sea, as well as perform the usual screen detection functions. These other duties not only distract from the general search, but also force the escorts to maintain a position very close to the high radiated noise of the high value units which may further degrade their detection performance.

The operating characteristics ofthe search units provide another common source of constraints. For example due to the endurance of the aircraft, helicopters can maintain sonobuoy fields only to about 40 miles from the launching platform. This limitation may result in sonobuoy fields being placed in high background noise regions or in portions of the search area where their contribution is less than optimal.

Communications requirements are the basis of another kind of constraint on screen units. Direct support submarines are an obvious example of a screen unit whose performance may face several limitations because of the communications requirement. VP aircraft may not be available because of assignment to communications relay, or may not be able to monitor as large a sonobuoy field due to collateral tasks.

Proper design must take these various constraints into consideration.

Screen measures of effectiveness. It has been mentioned various places that the SCREEN program contains both detection and localization measures. Historically, analysis of screens has been restricted to detection because it has been difficult to obtain general localization performance measures. A few simulations can perhaps assess the efficacy of a given fixed screen but lack in flexibility. The SCREEN program allows the potential for evaluating screens from the viewpoint of their localization capability.

Different types of screen units display widely varying detection and localization performance. Passive escorts which utilize the towed arrays frequently are characterized by very long range detection

capability. However, the ability of these sensors to localize the target is often very poor. In addition, the passive platforms are not necessarily quick response platforms, and so even if they could localize the targets, they might not be in a position to launch a weapon. Other screen elements such as helicopters using dipping sonar are extremely effective in localizing contacts once a detection has been made, but are fairly ineffective in achieving detections if the search area is very large. Active sonars generally provide good detection and localization capability but the target can almost always hear the active sonar before the sensing platform can detect the target, and so there is the serious difficulty of the target attempting to evade active screen elements.

A well defined screen in terms of both detection and localization performance would place its detecting units so that a target would be localized with high probability by the time it arrived at its launch region. If continuous full coverage is not possible, then early warning might enable quick response platforms to position themselves in order to prosecute. This type of mutual assistance among search units may provide the best overall screen design. While it is difficult enough to design a static screen if the two-sided game is allowed, designing a dynamic screen in which screen units react to their own detections is probably an order of magnitude more difficult. These questions lead to challenging and stimulating analysis.

Real time vs. study mode design. The logical approach to designing a static screen is with the study (batch) mode of operation of the SCREEN program. Candidate screen designs can be played against appropriate penetrating tactics and the results analyzed; the measure of performance is minimization of the probability of a successful attack by the penetrating submarine.

In the past, the SCREEN program has also been used in real time analysis to plan a dynamic reactive type of screen. In the work by Dr. T. L. Corwin at COMSUBPAC, which formed the basis for SCREEN, the programs were used during actual exercises involving a task force with direct support submarines; this reactive screen design was the principal application of the early programs. Further remarks along this line will be made in discussions of uses of the SCREEN program below.

Designing Penetration Tracks

The design of penetration tracks for the targets is, of course, simply the other side of the two-sided game. The principal parameters in this design involve the target's understanding of the screen which he is trying to penetrate.

In recent analyses of submarine alternatives, the SCREEN program was used to analyze penetration tactics against screens consisting of both passive and active screen elements where the considerations involved in the design of target penetration tracks included such things as:

(1) the relationship between target speed and radiated noise (which, of course, affected the performance of passive sensors in the screen and the set of feasible approach tracks),

(2) the requirement imposed on the penetrating submarine to perform a rough localization of the screen elements in order to design evasive maneuvers,

(3) the requirement imposed on the penetrating submarine to communicate, clear baffles, and perform other housekeeping functions,

(4) a total time budget during which the approach to attack had to be achieved,

(5) the distribution of initial arrival from which the task force penetration was assumed to commence,

(6) a selection among two alternative weapons with attendant launch range requirements,

(7) a selection among alternative launch positions for a given weapon, and

(8) (particularly applicable to diesel submarines) the ability to maintain sufficient reserve propulsion capacity to escape after the initial attack.

This analysis of target penetration tactics was probably more

elaborate than would typically be engaged in screen analysis, but it turned out that the care involved in target track design was needed to show the true effect of the differing candidate submarine capabilities. Reference [e] is the summary report of these analyses.

It should be noted that the target tracks designed for screen include uncertainty information in the placement of the target track. This uncertainty can reflect either: (1) the screen's uncertainty as to the target's location on an asssmed approach tactic, or (2) the target's assumed uncertainty in the location of screen units since the placement of his track on a relative motion board about the screen is subject to error due to his uncertainty concerning the location of screen units.

Performance Assessment

The performance assessment that is done by the SCREEN program serves the purpose of first designing screens and/or penetrating tactics, and second assessing the resultant performance of these defined screens. As mentioned before, there are two general measures of performance provided -- detection and localization -- and each of these has both short-term (snapshot) and a long term (cumulative) level of performance. We will discuss each of these in turn.

Snapshot coverage maps. The short-term performance of screens is used as the basis for so-called coverage maps which basically provide the pictorial representation of how well the screen searches out the coverage area of its sensors. For both detection and localization coverage maps, the basic condition assumed is as follows. A grid work is superimposed over the operating area selected. For an individual sensor or sensor group, it would be a region about that sensor or group or it could be the coverage area about the entire screen. The size of the coverage area is an input provided by the user. At every gridpoint of this coverage area, the performance of the sensor or sensor group or screen is evaluated conditioned upon the presence of a submarine target at that gridpoint.

Typical coverage maps are shown in Chapter VI. A detection map is basically derived from the sonar equation. By postulating a target at each of the gridpoints, the detection probability for the screen is evaluated and a number is placed on the gridpoint which is ten times the probability of detection computed for that gridpoint. A blank (no entry) indicates that the detection probability was less than .05. A star indicates that a value greater than .95 was obtained and a numeral between one and nine indicates that a value within .05 of that numeric quantity was obtained. By superimposing coverage maps for sensors or by calculating coverage maps for screens, it is possible to see at a glance where the high coverage areas and low coverage areas exist. As a first step in coverage design, the screen units would be shifted about so as to provide a pleasing appearance to the corresponding coverage maps. We have deliberately avoided stating what "pleasing" is

because it may be a function of a number of things. One may, for example, choose to allow gaps in detection coverage maps in order to provide overlapping coverage which would give better localization. One might also desire to provide increased coverage along the locations of most likely approach tracks and provide only limited coverage where the approach tracks are less likely.

A given coverage map is applicable to a specific set of radiated target noise levels. Since different approach tracks may entail different target noise patterns (because they entail different speeds) and hence different radiated noise levels, several coverage maps may be necessary in order to obtain a good composite coverage picture.

Localization coverage maps are analogous to detection coverage maps except that they provide information about snapshot localization. Since the snapshot localization maps consider short periods of time, localization is only achieved as there is an opportunity for a cross fix between passive detection sensors or an active detection (in which case, both range and bearing are obtained, and, therefore, a localization occurs immediately). In the design of a screen, the localization snapshot maps may be useful if it is believed that the opportunities for cross-fix or accurate coverage can be capitalized on in placing active forces or achieving attacks. Implicit in this is the requirement for communications which has not been discussed thus far.

Cumulative detection measures. The ultimate performance measures for the screen are the cumulative performance measures. Snapshot coverage maps are only an indication of detection and localization and do not take into account the kinematics of the problem which are all important in the final analysis.

The cumulative detection measures are of two types. First, is the calculation of cumulative probability of detection against specified target penetration tracks as a function of time. This probability can be used to calculate such measures as the probability of detecting a target prior to the arrival of a target at an attack launch position. Such a cumulative detection measure would be used in study (batch) mode of operation.

In addition, it is possible to use the cumulative detection measures in dynamic design of a screen by examining the posterior distribution of targets given search by the screen with no positive detection results. In this circumstance, the region where the coverage was heavy would have been well searched and therefore less likely to contain the target if no detection was in fact observed. On the other hand, lightly covered areas would tend to be more likely spots for targets to occur. Examination of these posterior maps may reveal target "hotspots," i.e., localized areas where the posterior map was significantly higher than elsewhere . After the SCREEN program is operated interactively, it would be logical in subsequent tactics to place reactive forces so as to cover these hotspots as they develop.

In actual use of a program similar to SCREEN in the Pacific, these

hotspots arose in a number of tactically significant ways. Frequently, parts of the planned coverage of a screen would remain uncovered due, for example, to equipment outages. Once these outages were incorporated into the screen evaluation, their effect would be revealed in the posterior maps generated.

By examining these posterior maps, it was possible to construct collective action which would search some of the gapped coverage area. By this means, it was possible to partially recover from system malfunctions by dynamically evolving the screen.

Cumulative localization is in essence a Kalman filter solution for a target following the postulated approach tactic. As time evolves, it is possible for a passive screen to develop a very accurate target localization and this is reflected in this localization measure. Thus, it is in principle possible to design a passive screen about a task force to localize a target by the time it penetrated to a predesignated critical region about the high value units. It would be appropriate then to place reactive forces or other attack weapon systems so that they could prosecute localizations achieved by the outer screen elements. To the best of our knowledge, no screen to date has been designed with this type of analysis and so the true value of the SCREEN program in aiding such design is untested at this point.

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CHAPTER III

PROGRAM OPTIONS AND OPERATION

This chapter tells how to use SCREEN and modify the underlying data files. It is assumed that the detailed files defining the situation already exist. The preparation of these files is the topic of Chapter IV. Some technical terms are defined in the corresponding section of Chapter IV, however most terms will be familiar to those acquainted with the sonar equation and its use.

The SCREEN program is built around an option list from which the user selects the tasks he wishes to perform. Upon completion of an option, the program again returns to the main level option list for further task selection. Some of the options lead in turn to a second level option list which defines the tasks that can be performed within that option. Other options request data input from the user prior to performing the selected task.

In this chapter two conventions are used without further comment. First, ranges of many parameters are limited by parameter statements which can be altered if necessary at the cost of recompiling the program: these are indicated by an asterisk -- for example, the current program can include up to 40* sensors in the screen formation. Second, user responses to program prompts are underlined.

Beginning the Program Execution

The actual sequence of user-provided instructions to begin the execution of SCREEN depends on the system level software of the host computer. The following instructions apply to the PRIME 400.

For the PRIME, the user accesses his directory, which contains the program SCREEN as well as various data files that have already been established. Program initiation begins by typing the command:

```
OK, SEG SCREEN
GO
```

The program first performs an automatic branch to option INIT which is described in full below and in Chapter IV. This loads the selected data files and sets the program clock to the current time and

time increment (DELTA T) as specified in the SENS file (if one is declared). There are three types of data files involved. These are, together with the mnemonic names:

(1) PROP file: this contains acoustic environmental data and certain sensor contours.

(2) SENS file: this contains the screen formation and sensor operating parameters, and

(3) TARG file(s): this contains target operating parameters. More than one target file may be declared.

In the simplest mode of operation, the files already exist on disk, in which case they are simply declared by the responses:

```
ENTER ACOUSTIC DATA FILE NO. (1-99): 1
ENTER SENSOR FILE NUMBER (1-99): 1
ENTER TARGET FILE NO. (1- 99): 1
ENTER TARGET FILE NO. (1- 99): 0
```

In this example, the files declared have the names PROP01,SENS01,and TARG01. Multiple target files may be declared. The request for target files is terminated by specifying file zero ('0'). The program then exits INIT. Note that the user can bypass declaring any type of file by entering a zero ('0').

The next computer response is to print a header which tells, among other things, the version of SCREEN that is being executed. This is followed by an automatic branch to option OUTPUT which is a request for a file to receive computer output:

```
ENTER FILENAME FOR OUTPUT (C for console): OUTPUT
APPEND TO PRESENT FILE (Y OR N): Y
```

This allows the user to specify the FORTRAN name of a disk file to receive the program output (in this case, named 'OUTPUT'). The selected file may be appended or erased and restarted. It does not matter on the PRIME whether the file already exists in the user directory. If the user specifies 'C' then output is directed to the user console. Program prompts and error messages are sent to the console in any event.

After exiting this call to OUTPUT, the program enters the main option level and requests the user to select an option.

```
******************************

INIT TSTEP POSIT MARGE BEAR COMI OUTPUT
DONE LLOSS LCON LPIM LSEN LTAR
ULOSS UCON UPIM USEN UTAR
PDSEN PDSTEP CDP CDPL MAP MAPL

******************************

SELECT MODE (HELP GIVES LIST):
```

Summary of Program Options

The program options are listed in Table I-1. Any option can be selected by giving the first four (4) letters of the name. A somewhat expanded explanation of the options is as follows:

COMI allows the user to specify an existing command file which the program will then follow. Upon completion of the command file, the program returns to the main program level.

OUTPUT selects a file for computer-generated output. There are two possible places for output to be directed: the user's console or a named output file. The user can alternate between these places by the use of the OUTPUT option. Each time computer results are directed to a named output file, the user may append to the end of the output file or he may rewrite that file.

DONE closes all active files in the computer program and performs a normal program termination.

INIT loads the PROP, SENS, and TARG data files as described in Chapter IV. If the files already exist in the user's directory, then the existing files are loaded; otherwise, the program prompts the user to create the missing files. The INIT option can be called at any time to switch among various data files.

TSTEP changes the current time step. It is possible either to increase or to decrease the current program time step. If the time step is increased, then the sensor and target files are updated to the new program time step. If the time step is decreased, the target files are unchanged, but the sensor file is truncated to the new program time step (i.e., the sensor information after the new time step is lost).

POSIT modifies the target distribution and can be used to incorporate posterior contact information on a target when the program is used in the interactive mode; it can also be used to constrain the target process in batch operation. With a little experience, combinations of POSIT, BEAR and MARG can be used to construct almost any desired target strategy. See Chapter V for an example of this use.

BEAR is used to incorporate bearing line contact information on a target, or to constrain the target process. This option is a companion to the POSIT option which does the same thing with spas.

MARG is used to constrain the target process to equal the given marginal distribution at the given time. At present it is only possible to constrain the target at one time step at

a time, although in principle, it is possible to make simultaneous multi-step constraints.

LLOSS lists the propagation and reverberation curves contained in the PROP file.

LCON lists the sensor contours contained in the PROP file.

LPIM lists the PIM and HVU parameters contained in the SENS file.

LSEN lists the sensor parameters contained in the SENS file.

LTAR lists the target parameters contained in the TARG file(s).

ULOSS modifies (updates) the propagation or reverberation curves contained in the PROP file.

UCON modifies the sensor contours contained in the PROP file.

UPIM (UHVU) modifies the PIM and HVU parameters contained in the SENS file.

USEN modifies sensor parameters contained in the SENS file.

UTAR modifies target parameters contained in the TARG file(s).

PDSEN displays acoustic coverage for a given sensor.

PDSTEP displays acoustic coverage for a sensor group or the entire sensor screen. Either detection only or both detection and localization coverage may be displayed.

CDP computes cumulative detection performance by a sensor group or the entire sensor screen against a selected set of targets. The targets selected must be taken from the set established in the INIT option.

CDPL computes both cumulative detection and localization performance by a sensor group or screen.

MAP computes the information contained in the CDP option and also displays the target prior and/or posterior probability distribution that results from the sensor search.

MAPL computes the information contained in the CDPL option and also displays the target prior and/or posterior probability distribution and localization that results from the sensor screen search.

Some of these options alter the files. Specifically, the following options may result in changes to the existing data files:

TSTEP	INIT	
POSIT	BEAR	MARG
UCON	UPIM	ULOSS
USEN		UTAR

Table IV-2 gives a fuller description of these changes. Some care must be exercised in the use of these options if it is desired to preserve certain files without change. Various means can be used to avoid loss of data such as creation of duplicate files or invoking machine protection on certain files.

These options are described in greater detail in the sections below.

Option COMI

The option COMI allows a user to specify an existing command file for input to the program. The command file must reside in the user's directory. On the PRIME a command file is a list of responses to program input requests. The computer interprets these responses line by line as if they were input from the user terminal.

Upon completion of the command file, the program will exit this option and return to main program level. The option calls a system subroutine to open the command file and then reads inputs from the command file. The command file starts as if the program is at the main option level (i.e., the first statement in the command file must be a valid program option) and must end with the lines:

```
COMI
TTY
```

which closes the command file and returns the user to the main level option menu for subsequent input from the console. For instance, if COFILE contains the following entries:

```
LTAR
0,0
COMI
TTY
```

then the use of COMI can be illustrated in the following session:

```
*******************************
SELECT MODE (HELP GIVES LIST): COMI
ENTER FILE NAME :COFILE
*******************************
SELECT MODE (HELP GIVES LIST): LTAR
ENTER START,STOP STEPS (0 -  8)0,0
*******************************
SELECT MODE (HELP GIVES LIST): COMI
ENTER FILE NAME :TTY
*******************************
SELECT MODE (HELP GIVES LIST):DONE
```

The COMI option can be used to advantage for identical runs with different data files. The data files can be loaded in and then a command file used to perform the repetitive tasks. See Chapter V for examples. The COMI option can also be used to great advantage in the

creation of complicated files. Chapter IV discusses the file creation details. There are two primary advantages of this method of file creation. First, if an error is found in the file created, the corresponding error may be corrected in the command file and the file recreated very quickly and without the possibility of generating new errors by different mistakes in typing. Second, if the file is altered or destroyed, it may quickly be regenerated in its original condition.

Note on COMI use. On the PRIME computer, the capability exists to create COMI files directly from COMO (COMMAND Output) files. Because of the great time savings possible by doing this, a description of the procedure follows.

The PRIME has the capability to create a file which exactly duplicates all of the information that appears on the user terminal -- including all program prompts and user responses. Such a file is called a COMO file (COMMAND Output) and is established by the system level command: COMO filename. After an interactive session with SCREEN, the COMO file is closed by the system level command 'COMO -END'.

The COMO file thus produced includes both system and user responses. The PRIME system editor can be used to strip off all system responses, leaving a file containing only user responses to the system prompts. The following command file accomplishes this:

```
* THIS FILE STRIPS A COMO FILE FROM SCREEN TO PRODUCE A COMI FILE.
* IT IS ASSUMED THAT ALL USER INPUT IS PRECEEDED BY A PROMPT WHICH
* ENDS IN ':'. THE COMO FILE IS NAMED 'TEST.'

ED TEST
C//./500000
T
N:G D:EIF :*
T
F  :C/ //:*
FIL TEST.COMI
CO TTY
```

This method of producing a COMI file is of considerable value, particularly if repetitive and detailed user responses are involved. The use of the SCREEN program in an interactive mode prompts the user to give the proper sequence of responses. Subsequent production of a COMI file preserves the session for future use.

Option OUTPUT

This option allows the subsequent output to be directed to either the console or to a disk file named by the user. Prompts and messages will always appear at the terminal. For instance, this sequence:

```
SELECT MODE (HELP GIVES LIST): OUTPUT
ENTER FILENAME FOR OUTPUT (C for console): C
```

will cause subsequent output to appear at the terminal. If the OUTPUT option is exercised later in the session in this manner:

```
SELECT MODE (HELP GIVES LIST): OUTPUT
ENTER FILENAME FOR OUTPUT (C for console): OUTPUT
APPEND TO PRESENT FILE (Y OR N): Y
```

subsequent output will be written to the file named 'OUTPUT' in the user directory. Changes can be made back and forth between the terminal and any specified output file by selection of this option.

Option DONE

This option exits the program. It is selected at the end of the run.

SELECT MODE (HELP GIVES LIST): DONE

Use of option DONE closes all active files and terminates execution of the program.

Option INIT

The option INIT is automatically executed at the beginning of the program without user specification. It may also be specified later in the program to restart a problem or set up another problem.

The following example shows the use of option INIT to load existing files:

```
SELECT MODE (HELP GIVES LIST): INIT
ENTER ACOUSTIC DATA FILE NO. (1-99): 1
ENTER SENSOR FILE NUMBER (1-99): 1
ENTER TARGET FILE NO. (1- 99): 1
ENTER TARGET FILE NO. (1- 99): 2
ENTER TARGET FILE NO. (1- 99): 0
```

If the files specified above had not existed, the INIT option would provide prompts to enable the user to create the specified files. Chapter IV describes creation of input files. Multiple target files may be loaded, so the option INIT is exited by specifying a target file number of 0. Entering a zero for acoustic or sensor file number will cause the program to bypass loading that type of file.

Option TSTEP

Option TSTEP is used to increase or decrease the current time step. This time step is the current time step of the sensor file SENS, if one has been loaded, or the minimum time step among the target files if no sensor file has been loaded. For newly created files, the time step is zero and TSTEP is typically used to increase it.

The option TSTEP is exercised in the following example:

```
SELECT MODE (HELP GIVES LIST): TSTEP
ENTER NEW PROGRAM TIME STEP: 12
```

No printed output is produced by this option.

The TSTEP option will work with any combination of PROP, SENS, or TARG files loaded or omitted. It alters the input data files in the following manner:

(1) The PROP file is unchanged by option TSTEP.

(2) Each SENS file has associated with it a current time step which becomes the program time step when the sensor file is loaded. The option TSTEP will alter the sensor file depending on the size of the program time step compared to the time step specified:

(a) If the time step specified in TSTEP is less than or equal to the program time step, the sensor file time step is set to the new time and all sensor information for times after the new time is deleted from the sensor file. This allows the user to "back-up" the sensor file and then redefine it in subsequent calls to USEN and TSTEP.

(b) If the new time step is greater than the program time step, the sensor file will be extended to the new time step using the sensor parameters declared for the current time step.

(3) Each target file has associated with it a time step which may differ from the program time step. The option TSTEP will affect the target file in one of two ways:

(a) If the new time step is less than or equal to the current target file time step, then the corresponding target file is unchanged. This is different from the effect on sensor files. It is not possible to "back-up" a target file.

(b) If the new time step is greater than the current target file time step, the program will advance the target file to the new time step using the target parameters declared for the current target file time step. It will then reset the target file time step to the new time step.

The option TSTEP is repetitively used in creating sensor or target files. See Chapter V for an extended example of this.

Option POSIT

This option allows the user to incorporate a piece of positive information into the target location probability distribution.

This option adds the positive information to an information matrix which is later inverted to obtain the target covariance matrix. A previously input piece of positive information can be removed by this option if the user specifies detection deletion. In this case, the inputs will be subtracted from the information matrix. This has the effect of nullifying the previously processed detection. In all cases, the user can bypass processing by refusing to verify the SPA parameters.

The following command sequence causes the program to process a contact:

```
SELECT MODE (HELP GIVES LIST): POSIT
INPUT TARGET FILE NO.: 1
INPUT SPA TIME STEP: 5
ENTER SPA COORDINATES (X,Y) (nm): 0,0
ENTER TARGET SPA PARAMETERS:
2-SIG S-MAJ, S-MIN AXIS, MAJ AXIS BRG:5,5,0
TARGET DETECTION (Y OR N): Y
DO YOU VERIFY SPA PARAMETERS (Y OR N): Y
```

In the next command sequence, the user decides to delete the contact processed above, but changes his mind at the last minute:

```
SELECT MODE (HELP GIVES LIST): POSIT
INPUT TARGET FILE NO.: 1
INPUT SPA TIME STEP: 5
ENTER SPA COORDINATES (X,Y) (nm): 0,0
ENTER TARGET SPA PARAMETERS:
2-SIG S-MAJ, S-MIN AXES (NM), MAJ AXIS BRG(DEG):5,5,0
TARGET DETECTION (Y OR N): N
DELETE DETECTION (Y OR N): Y
DO YOU VERIFY SPA PARAMETERS (Y OR N): N

DETECTION NOT PROCESSED
```

Here the target file number must be among those loaded and the input SPA time step must be no greater than the target file current time.

An input of Y to the TARGET DETECTION prompt will cause the program to add the detection to the information matrix. An input of Y to the DELETE DETECTION will cause the program to subtract the detection from the information matrix.

Option BEAR

This option allows the user to incorporate a piece of positive information into the target location probability distribution. Its operation and use is similar to POSIT.

By exercising this option, the user can input a bearing line contact or constrain the target to satisfy a bearing line constraint at a given timestep. The combination with the target prior is done in a Bayesian fashion utilizing the Kalman filter routines, as is the case with POSIT. It is not currently possible to delete bearing inputs after they have been processed.

The following command sequence results when this option is called:

```
SELECT MODE (HELP GIVES LIST): BEAR
INPUT TARGET FILE NO.: 3
INPUT BEARING TIME STEP: 10
ENTER SENSOR COORDINATES (X,Y) (nm): 10,175
ENTER TARGET BEARING PARAMETERS:
BEARING (DEG. FROM N), STD. DEV.(DEG.): 0,1
DO YOU VERIFY BEARING PARAMETERS (Y OR N): Y
```

Option MARGE

This option allows the user to constrain the target distribution to equal the given marginal at the stated time. The distribution at other times is adjusted to agree with the diffusion process together with other positive information that may have been entered previously. That is, if several marginal constraints or bearings have been entered, only the last one entered will necessarily be satisfied exactly.

It is currently not possible to delete a marginal constraint after it has been processed.

The following sequence of commands will implement this option:

```
SELECT MODE (HELP GIVES LIST): MARGE
INPUT TARGET FILE NO.: 1
INPUT CONSTRAINT TIME STEP: 10
ENTER CONSTRAINT COORDINATES (X,Y) (nm): 10,175
ENTER TARGET CONSTRAINT PARAMETERS:
2-SIG S-MAJ, S-MIN AXIS (nm), MAJ AXIS BRG (deg): 12,3,11,8,0

DO YOU VERIFY CONSTR. PARAMETERS (Y OR N): Y
```

Option LLOSS

The LLOSS option allows the user to list the propagation loss and associated active reverberation curves. Since there may be up to 10* propagation loss curves in a single environmental/sensor contour file, the user is asked to select which ones to print among those available. A zero input as a propagation loss curve number causes return to the main program. A typical command sequence is:

```
SELECT MODE (HELP GIVES LIST): LLOSS
ENTER PROP LOSS CURVE NO.  (1- 2): 1
ENTER PROP LOSS CURVE NO.  (1- 2): 0
```

This option requires that the environmental/sensor contour file be loaded; the sensor and target files are optional.

Examples of the output are given in Chapter V.

Option LCON

The option LCON allows the user to list the sensor contours. Since up to 20* aspect contours may be contained in a single environmental/sensor contour file, the program asks the user to specify which contours to list. An entry of zero causes an exit from this option. A typical command sequence is:

```
SELECT MODE (HELP GIVES LIST): LCON
ENTER ASPECT CONTOUR NO. (1- 5): 1
ENTER ASPECT CONTOUR NO. (1- 5): 0
*******************************
```

This option requires that the environmental/sensor contour file be loaded; the sensor and target files are optional.

See Chapter V for examples of the use of this option.

Option LPIM

The option LPIM allows the user to list the PIM and HVU parameters at the specified time steps. The command sequence is:

```
SELECT MODE (HELP GIVES LIST): LPIM
ENTER START,STOP STEPS (0 -  12) 1,4
******************************
```

This option requires that the sensor file be loaded; the environmental/sensor contour and target files are optional.

A sample of the output from this option is in Chapter V.

Option LSEN

The option LSEN allows the user to list the sensor parameters for a range of time steps within those of the problem. This option requires that the sensor file be loaded: loading the PROP and target files is optional. If no PROP file has been loaded, the labels for the aspect contour and propagation loss curve will appear as blanks: if a PROP file has been loaded, the index labels will appear.

A typical command sequence for LSEN is as follows:

```
SELECT MODE (HELP GIVES LIST): LSEN
ENTER START,STOP STEPS (0 - 12) 11,12
```

Samples of an output file produced by LSEN are shown in Chapter V.

Option LTAR

The LTAR option allows the user to list the target parameters within the range of time steps for which it has been defined. This option requires that at least one target file be loaded; loading a PROP file and a sensor file are optional. However, if a sensor file is not loaded, then the mean relative position and velocity will be calculated relative to a PIM at 0,0 with 0 velocity. That is, the relative and absolute position and velocity of the target will be the same. The program will provide the table for all target files which have been loaded.

A typical command sequence is:

```
SELECT MODE (HELP GIVES LIST): LTAR
ENTER START,STOP STEPS (0 - 12) 4,6
*******************************
```

A sample output file produced by the LTAR option is given in Chapter V.

Option ULOSS

The ULOSS option allows the user to change or add to existing propagation loss and reverberation curves. The option branches to the same subprogram used by INIT to create such curves. A typical command sequence is:

```
SELECT MODE (HELP GIVES LIST): ULOSS
ENTER PROP LOSS CURVE NO. (1- 10): 2
ENTER THE PROP LOSS CURVE LABEL: CURVE#2
AMBIENT NOISE (db: 50
ENTER RANGE (nm) , PROP LOSS (db)  PAIRS
(ENTER PROP LOSS -200 TO DELETE RANGE ENTRY)
(ENTER 'END' TO EXIT)
DATA POINT: 10,185
DATA POINT: 15,200
DATA POINT: END
ENTER ACT. SOURCE LEVEL AND DELT RD FOR REVERB(db) (0= EXIT)
LS (db) AND DELTRD: 135,10
ENTER REVERB CURVE LABEL: CURVE#12
ENTER RANGE (nm) , REVERB (db) PAIRS
ENTER REVERB -200 TO DELETE RANGE ENTRY
ENTER 'END' TO POP OUT
DATA POINT: 1,5
DATA POINT: 2,2
DATA POINT: 0,0
DATA POINT: END
ENTER PROP LOSS CURVE NO. (1- 10): 0
```

The meanings of these inputs are discussed in Chapter IV under propagation loss input.

This option requires only that a PROP file number be specified. It is unnecessary to specify a sensor file number or a target file number. There is no printed output produced by this option. This option may also be used to correct or expand the environmental portion of an PROP file which was previously declared in INIT.

If the number of a previously established propagation loss curve is specified, the former curve is lost and replaced by the new curve.

Option UCON

The UCON option allows the user to change or add to existing sensor contours. The option branches to the same subprogram used by INIT to create such contours. A typical command sequence is:

```
SELECT MODE (HELP GIVES LIST): UCON
ENTER ASPECT CONTOUR NO. (1-20): 1
ENTER THE ASPECT CONTOUR LABEL: CONTOUR#1
ENTER DIRECTIVITY INDEX (db) : 2
ENTER BEARING(deg), DELTA SELF-NOISE(db), BW(+-3db) TRIPLES
(ENTER 'END' TO POP OUT)
(ENTER DELTA SELF-NOISE = -100 TO DELETE ENTRY
DATA POINT: 0,5,36
DATA POINT: 20,0,48
DATA POINT: 340,5,48
DATA POINT: END
ENTER REFERENCE BEAMWIDTH (+-3 db DOWN):6
ENTER SE,SIG.BRG,RELAX.TIME (min):-10,15,30
ENTER SE,SIG.BRG,RELAX.TIME (min):0,6,15
ENTER SE,SIG.BRG,RELAX.TIME (min):15,3,15
ENTER SE,SIG.BRG,RELAX.TIME (min):END
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min):-10,40,30
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min):0,10,15
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min):15,0,15
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min):END
ENTER ASPECT CONTOUR NO. (1-20): 0
```

The meanings of the various inputs are described in Chapter IV under aspect contour inputs. This option may be used to input aspect contours when constructing PROP files. This option provides no output to the user. The results of the changes may be examined using the LPIM option.

This option may be used to add or delete contours in an existing file. If a contour with the same number did not previously exist, the one entered here is added to the file. If a contour with that number previously existed, then the old contour is deleted and replaced with the contour entered.

Option UPIM

The UPIM option allows the user to change various PIM and HVU parameters. A typical command sequence is:

```
SELECT MODE (HELP GIVES LIST): UPIM
ENTER KEY ( / GIVES LIST): /
0=POP OUT  1=UPDATE PIM COORD  2=UPDATE PIM SPEED
  HEADING  3=CHANGE HVU LABEL  4=UPDATE HVU COORD
5=UPDATE HVU NOISE SOURCE INDEX/LEVEL
6=CHANGE START/DELTA TIMES
```

The user is presented with a set of options for updating PIM. If the user wishes to update the PIM coordinates, he could do so like this:

```
ENTER KEY ( / GIVES LIST): 1
INPUT PIM COORD (X,Y) (nm) : 0,0
```

The new PIM coordinates (in nm) will apply to the current time step.

The PIM coordinates are used for centering output maps for options DPSTEP, MAP, and MAPL. PIM coordinates and velocity are also used to calculate the mean relative position and relative velocity of a target in LEAR. It is occasionally useful to move PIM around in order to locate particular portions of maps within the display bounds.

If the user wishes to update the PIM speed and heading, he might input the following:

```
ENTER KEY ( / GIVES LIST): 2
INPUT PIM SPEED (nm), HEADING (deg): 10,0
```

The PIM speed is in kts and the PIM heading in degrees clockwise from north. These inputs will replace the current values and are used to determine HVU motion if the TSTEP is performed on the SENS file subsequently.

The user may change the label of an HVU in the following sequence:

```
ENTER KEY ( / GIVES LIST): 3
ENTER HVU NO. (0=POP OUT): 1
ENTER HVU LABEL($$=DELETE): HVU#1
ENTER HVU NO. (0=POP OUT): 0
```

All of the HVUs may be relabeled in this way in one specification of key 3. Entering an HVU number of 0 causes the program to return to key specification after asking for the PIM coordinates. An entry of 'SS' removes that HVU from further consideration but does not delete the HVU parameters. An HVU that was previously declared 'SS' can be reestablished by giving it a name.

Since the HVU and sensor labels are stored only once in the SENS file, rather than for each time step, the most recent declaration of the labels is used for all time steps. Thus in particular, the use or deletion of the 'SS' label removes or inserts the corresponding sensor or HVU for all time steps.

The PIM coordinates input will apply to the current time step. Key 3 can be used in conjunction with keys 4 and 5 to define previously undefined HVUs.

Key 4 allows the user to specify HVU position:

```
ENTER KEY ( / GIVES LIST): 4
ENTER HVU NO., X-COORD, Y-COORD (nm): 1,10,10
ENTER HVU NO., X-COORD, Y-COORD (nm): 0
```

This new HVU position will replace the current position for any previously defined HVU. A zero is used to pop out of key 4.

Key 5 allows the user to define an index and source level of the noise the HVU radiates:

```
ENTER KEY ( / GIVES LIST): 5
ENTER HVU NO., SOURCE INDEX, LEVEL (db): 1,1,165
ENTER HVU NO., SOURCE INDEX, LEVEL (db): 0
```

This will replace any value already input for the indexed HVU or will define a new value if no value has previously been defined. The change only affects the noise description of the HVU at the current time step.

Key 6 allows the user to specify the start date time group and the length of a time step if the current time step of the sensor file is zero:

```
ENTER KEY ( / GIVES LIST): 6
ENTER START DTG (DD,HH,MM): 00,00,00
ENTER DELTA T (hrs): .25
```

If the user attempts to enter this key when the time step is

larger than zero (in this case 12), he will receive the following message:

```
ENTER KEY ( / GIVES LIST): 6
START AND DELTA TIMES MAY BE CHANGED ONLY AT TSTEP 0.
THE CURRENT TIME STEP IS 12.
TSTEP MAY BE USED TO RETURN TO TIME STEP 0.
```

Option USEN

The option USEN is used to modify parameters in the sensor file at the current time step and to add, delete, or reorder sensors when the current time step of the sensor file is zero. Some users prefer the option USEN to construct sensor files instead of doing it under option INIT. Only the sensor file need be loaded to exercise option USEN.

Certain capabilities are provided in USEN that are not available in INIT, such as: providing distinct names for different sensors within a group or for copies of groups (key 2); reordering the sensors (key 13), etc. Often the user will want to use LSEN to list the current values as they appear in the sensor file prior to making changes in USEN. The changes can be verified by again listing the file contents with LSEN.

When the user specifies the option USEN, he will be asked to enter a key specifying how he wishes to modify the sensor file:

```
SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 14
 0 = POP OUT
 1 = ADD NEW SENSORS
 2 = CHANGE SEN LABEL
 3 = UPDATE SEN TYPE
 4 = UPDATE SEN COORD
 5 = UPDATE SEN SPEED/HEADING
 6 = UPDATE RD AND LN-SNR LEVELS
 7 = UPDATE PROPLOSS/ASPECT/HVU NOISE INDEX
 8 = UPDATE LAMBDA/SIGMA
 9 = UPDATE SCAN RATE, INTEGRATION TIME, OR AVAILABILITY
10 = CHANGE CONFIGURATION
11 = CHANGE GROUPING AND GROUP CORRELATION
12 = CHANGE SENSOR RADIATED NOISE LEVELS
13 = REORDER THE SENSORS
```

Options 1 and 13 can be invoked only at time step zero. Option 2 changes the label for all timesteps. The user must specify the timesteps ranges for options 3,6,7,8,9,11,and 12. All other options change the parameter indicated at the current time step of the sensor file. Entering a sensor number that the program does not recognize causes an exit from options 2 through 12.

<u>Key 1</u> allows the user to add or delete sensors at time step zero. Its use is analogous to the construction of sensor files under option INIT described in Chapter IV. However, rather than requiring the user to enter all information, a list of keys is provided. A typical command sequence is:

```
ENTER KEY (14 GIVES LIST): 1

PICK KEY 0 TO 4: 0=EXIT  1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 1
ENTER SENSOR FILE NAME:SENSOR FILE #1
ENTER START DTG (DD,HH,MM): 00,00,00
ENTER DELTA T (hrs) :.25

PICK KEY 0 TO 4: 0=EXIT  1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 2
ENTER INITIAL PIM COORD (X,Y) (nm): 0,0
ENTER INITIAL PIM SPEED (kts),HEADING (deg): 10,0

PICK KEY 0 TO 4: 0=EXIT  1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 3
ENTER THE HVU NO. (1-  5): 1
ENTER THE HVU LABEL (ENTER $$ TO DELETE): HVU#1
ENTER HVU INITIAL COORDINATES (nm): 0,0
ENTER HVU SOURCE INDEX AND LEVEL (db)(0=POP OUT): 1,165
ENTER HVU SOURCE INDEX AND LEVEL (db)(0=POP OUT): 0
ENTER THE HVU NO. (1-  5): 0

PICK KEY 0 TO 4: 0=EXIT  1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 4
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): Y
ENTER SENSOR LABEL: ($$=DELETE): SENSOR#2
ENTER TYPE OF SENSOR (P, A, L, O): P
ENTER INITIAL COORDINATES (X,Y) (nm): 15,15
ENTER SPEED (kts) AND HEADING (deg): 10,0
ENTER NOISE NO. AND NOMINAL SELF-NOISE LEVEL (db): 25,30
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=POP OUT): 1,135
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=POP OUT): 0
ENTER PL NO., ASPECT NO.,TGT NOISE NO.: 1,1,1
ENTER LAMBDA AND SIGMA: 1,9
ENTER SCAN TIME AND INTEGRATION TIME (min.),1,5
ENTER PROBABILITY SENSOR IS AVAILABLE(RANGE 0-1): .95
MORE SENSORS IN SUBGROUP OF GROUP (Y OR N): N
ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): N
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): N
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): N

PICK KEY 0 TO 4: 0=EXIT  1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 0
```

Note that INIT and key 1 both number sensors in the order that they are input to the file. This ordering can be changed by using key 13.

Key 2 allows one to change the sensor label. If there is no sensor with the indexed sensor number, the program will pop out of this mode:

```
ENTER KEY (14 GIVES LIST): 2
ENTER SENSOR NO.,SENSOR LABEL: 2,BUOY#2
ENTER SENSOR NO.,SENSOR LABEL: 3,BUOY#3
ENTER SENSOR NO.,SENSOR LABEL: 0
```

Key 3 allows one to change the type of the sensor as follows:

P	passive
A	active
LA	line array
0	off.

Either 'L' or 'LA' is acceptable for line arrays.

The difference between P and LA is that the evaluation of an LA sensor also considers interfering noise on the mirror beams. If there is no sensor with the specified index, the program will pop out of this mode:

```
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 - 1): 0,1
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 2,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 0
```

Because this changes the sensor type only at the time steps specified by the user, this portion of the USEN option can be used to turn sensors off and on. This is one way to simulate periods when a given sensor is not functioning, as in the sprint phase of the sprint and drift search tactic, or in the trucking phase of a helicopter dipping sonar.

Key 4 allows one to modify the sensor coordinates. If there is no sensor with the specified index, the program will pop out of this mode:

```
ENTER KEY (14 GIVES LIST): 4
ENTER SENSOR NO.,SENSOR COORD. (X,Y) (nm): 1,0,5
ENTER SENSOR NO.,SENSOR COORD. (X,Y) (nm): 0
```

The new sensor coordinates apply to the indexed sensor only at the time step the sensor file defines as current. Note that no assumption of continuous motion is made. A sensor may jump from one place to another under this option. Since the number of sensors remains constant

throughout the problem, this option may be used to replace sensors. For instance, when the useful life of a sonobuoy field is over, the field can be moved to a new location hundreds of miles away by using this option (perhaps after being turned 'off' with key 3 during the replacement time). See Chapter V for an example of this.

Key 5 allows one to change the speed and heading of a sensor. If there is no sensor with the specified index, the program will pop out of this mode:

```
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 1,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
```

The new speed and heading (in degrees clockwise from north) apply only at the time step that the sensor file defines as current. This option is used when sensors are to change speed or direction of travel, for example, a zigging sensor platform.

Key 6 allows one to change the recognition differential and nominal self-noise for an indexed sensor. If there is no sensor with the specified index, the program will pop out of this mode:

```
ENTER KEY (14 GIVES LIST): 6
ENTER START,STOP STEPS (0 - 1): 0,1
ENTER SENSOR NO.,RD, AND NOMINAL SELF-NOISE LEVEL: 1,15,30
ENTER SENSOR NO.,RD, AND NOMINAL SELF-NOISE LEVEL: 0
```

The sonar parameters apply at the time steps the user designates. This option may be used to introduce periodic "noisy periods" of the sensor platform and the resulting changes in self-noise or an assumed shift in processor mode and the resulting change in RD.

Key 7 allows the user to change the indices of the propagation loss curve, the sensor aspect contour, and the target noise level which apply at the time steps the user designates. Entering a nonexistent sensor index will cause the program to pop out of this mode:

```
ENTER KEY (14 GIVES LIST): 7
ENTER START,STOP STEPS (0 - 1): 0,1
ENTER SENSOR NO.,PL. NO.,ASPECT NO.,TGT NOISE NO.: 1,1,1,1
ENTER SENSOR NO.,PL. NO.,ASPECT NO.,TGT NOISE NO.: 0
```

This option allows the user to change the propagation loss, the aspect contour, and the noise level index of the target in the course of the problem. For example, the propagation loss may change when a submarine goes from shallow to deep for its search.

Key 8 allows the user to update the values of lambda and sigma used to describe the (lambda, sigma) process which models sensor detection. A nonexistent sensor file index causes the program to exit this mode:

```
ENTER KEY (14 GIVES LIST): 8
ENTER START,STOP STEPS (0 -  1): 0,1
ENTER SENSOR NO., LAMBDA, SIGMA: 1,1,9
ENTER SENSOR NO., LAMBDA, SIGMA: 0
```

The values of lambda and sigma will apply to the time steps the user designates.

Key 9 allows the user to alter the scan time, integration time, and probability of availability for a sensor. Input of a nonexistent sensor index will cause the program to exit this mode:

```
ENTER KEY (14 GIVES LIST): 9
ENTER START,STOP STEPS (0 -  1): 0,1
ENTER SENS NO., SCAN TIME   INT. TIME: 1,1,5
ENTER SENSOR PROBABILITY OF AVAILABILITY: .95
ENTER SENS NO., SCAN TIME   INT. TIME: 0
```

The new values apply at the time steps the user designates. Note that an availability of zero ('0') is equivalent in its effect to having the sensor turned off. However, the program is more efficient if the sensor is declared to be off.

Key 10 gives a list of the current configuration values and allows the user to change these. The configuration values are not used by program computation in this version of the program. The meaning of the configuration value is that if it matches at two time steps, the sensors are assumed to be in the same relative positions. A typical sequence follows:

```
ENTER KEY (14 GIVES LIST): 10

CURRENT CONFIGURATION VALUES
        1    1
ENTER TIME STEP, CONFIG. NO.(0=POPOUT): 2,2
ENTER TIME STEP, CONFIG. NO.(0=POPOUT): 0
```

Because the configuration values are no longer used in computations, the user may define them anyway he likes. Since they appear in LSEN listings, it may be helpful to make the configuration numbers match whenever the sensor screen is in the same relative configuration.

Key 11 allows the user to change the sensor groupings and the group correlations. Each specified sensor is assigned to the group indicated. If a number between 0 and 1 is specified it will be the new group correlation. If a negative number is specified for group correlation, the group correlation will remain unaltered. Specification of a nonexistent sensor causes the program to exit this mode:

```
ENTER KEY (14 GIVES LIST): 11
ENTER START,STOP STEPS (0 - 1): 0,1
ENTER SENS NO., GROUP NO.: 1,1
ENTER GROUP CORRELATION (NEG IS NO CHANGE): .5
ENTER SENS NO., GROUP NO.: 0
```

The groupings of sensors are spatial. In the model, observations reported by two sensors in the same group are treated as partially correlated and partially independent. (See the discussion in Chapter IV.) Sensor motion may necessitate regrouping of the sensors at various time steps. The sensor groupings apply at the time steps the user designates.

Key 12 allows the user to alter the source levels for any of the defined sensors. If the program does not recognize the indexed sensor, it will exit this mode:

```
ENTER KEY (14 GIVES LIST): 12
ENTER START,STOP STEPS (0 - 1): 0,1
ENTER SENSOR NO.,INDEX, SOURCE LEVEL (do) (0 TO EXIT): 1,1,165

ENTER SENSOR NO.,INDEX, SOURCE LEVEL (db) (0 TO EXIT): 0
```

The new source levels will apply at the time steps the user has specified.

Key 13 may be specified only if the current time step of the sensor file is zero. This option allows the user to reorder the sensors. Note that it is not necessary to use every sensor number already defined, that an old sensor number may be used several times, and that the total number of sensors at the end may be more than at the start of this option. This and the other USEN options provide a great deal of flexibility. At times one may revamp an existing sensor file to obtain the screen necessary to evaluate questions requiring a quick response. The program will ask for the new numbers one at a time:

```
ENTER KEY (14 GIVES LIST): 13
NEW SENSOR NUMBER  1 IS OLD SENSOR NUMBER: 1
NEW SENSOR NUMBER  2 IS OLD SENSOR NUMBER: 2
NEW SENSOR NUMBER  3 IS OLD SENSOR NUMBER: 3
```

```
NEW SENSOR NUMBER  4 IS OLD SENSOR NUMBER: 6
NEW SENSOR NUMBER  5 IS OLD SENSOR NUMBER: 4
NEW SENSOR NUMBER  6 IS OLD SENSOR NUMBER: 5
NEW SENSOR NUMBER  7 IS OLD SENSOR NUMBER: 9
NEW SENSOR NUMBER  8 IS OLD SENSOR NUMBER: 7
NEW SENSOR NUMBER  9 IS OLD SENSOR NUMBER: 8
NEW SENSOR NUMBER 10 IS OLD SENSOR NUMBER: 12
NEW SENSOR NUMBER 11 IS OLD SENSOR NUMBER: 10
NEW SENSOR NUMBER 12 IS OLD SENSOR NUMBER: 11
NEW SENSOR NUMBER 13 IS OLD SENSOR NUMBER: 13
NEW SENSOR NUMBER 14 IS OLD SENSOR NUMBER: 15
NEW SENSOR NUMBER 15 IS OLD SENSOR NUMBER: 14
NEW SENSOR NUMBER 16 IS OLD SENSOR NUMBER: 16
NEW SENSOR NUMBER 17 IS OLD SENSOR NUMBER: 17
NEW SENSOR NUMBER 18 IS OLD SENSOR NUMBER: 18
NEW SENSOR NUMBER 19 IS OLD SENSOR NUMBER: 19
NEW SENSOR NUMBER 20 IS OLD SENSOR NUMBER: 20
NEW SENSOR NUMBER 21 IS OLD SENSOR NUMBER: 21
```

If a nonexistent sensor number is specified for an old sensor number, the program will repeat the last prompt. The sensor number determines the order in which the sensors will appear in LSENS listings.

Exit this option with a key of 0:

```
ENTER KEY (14 GIVES LIST): 0
```

Option UTAR

This option allows the user to modify the parameters contained in the target file. It requires that at least one target file be loaded, but the user need not specify an environmental/contour file or a sensor file.

When a user specifies UTAR, the following will appear:

```
SELECT MODE (HELP GIVES LIST): UTAR
ENTER TARGET NO.: 2
ENTER KEY (7 GIVES LIST): 7
 0 = EXIT
 1 = CHANGE TARGET LABEL
 2 = UPDATE VELOCITY CHANGE RATE
 3 = UPDATE SPEED AND HEADING
 4 = UPDATE STANDARD DEVIATION IN TARGET SPEED AND HEADING
 5 = UPDATE INDEX AND LEVEL
```

First, the user is asked to specify the target number he wishes to update and then he is asked to choose from the list how he wishes to update that target. If the user should enter a target number which has not been loaded, a warning is issued, followed by an opportunity to enter a valid target number:

```
ENTER TARGET NO.: 1
THIS TARGET FILE IS NOT ACTIVE
ENTER TARGET NO.: 2
```

Key 0 exits changes to the current target file and permits the specification of the next target file to be modified. After making all changes to all target files, one uses key 0 to exit to the next target file subsection and again uses key = 0 to exit to the main option table.

Key 1 allows the user to change the target label:

```
ENTER KEY (6 GIVES LIST): 1
ENTER TARGET LABEL: TARGET#2
```

Key 2 allows the user to change the average target time on leg:

```
ENTER KEY (6 GIVES LIST): 2
```

```
ENTER NEW TARGET TIME ON LEG (hrs): 4
```

If the program time step does not equal the target file time step, this key cannot be used. The following message will be printed in this case:

```
ENTER KEY (6 GIVES LIST): 2
UPDATE CANNOT BE DONE FOR TARGET 1 BECAUSE PROGRAM TIME STEP
DOES NOT EQUAL TARGET TIME STEP  12
```

Key 3 allows the user to change the target speed and heading and also the standard deviation in the target speed and heading:

```
ENTER KEY (6 GIVES LIST): 3
ENTER NEW TARGET SPEED (kts),HEADING (deg): 10,180
ENTER NEW STD. DEV. IN TARGET SPEED,HEADING: 1,5
```

This key can only be entered if the program step equals the target file time step. If this is not the case, the program will print the following message:

```
ENTER KEY (6 GIVES LIST): 3
UPDATE CANNOT BE DONE FOR TARGET 1 BECAUSE PROGRAM TIME STEP
DOES NOT EQUAL TARGET TIME STEP  12
```

Key 4 allows the user to change the standard deviation in the target speed and heading without changing the target speed and heading:

```
ENTER KEY (6 GIVES LIST): 4
ENTER NEW STD. DEV. IN TARGET SPEED,HEADING: 1,5
```

This key can be entered only when the target file time step equals the program time step.

Key 5 allows the user to change the target noise index and levels. A typical sequence follows:

```
ENTER KEY (6 GIVES LIST): 5
ENTER START,STOP STEPS (0 - 1)0,1
ENTER TGT NOISE INDEX AND LEVEL (db): 1,165
ENTER TGT NOISE INDEX AND LEVEL (db): 2,160
```

ENTER TGT NOISE INDEX AND LEVEL (db): 0

These noise levels apply at the interval of time steps specified. Note that any noise level may be changed for any interval of time steps up to and including the current target time step.

Option PDSEN

The option PDSEN displays acoustic coverage for a specified sensor. A typical input sequence follows:

```
******************************

SELECT MODE (HELP GIVES LIST): PDSEN
ENTER START,STOP STEPS (0 - 42): 0,10
ENTER SENSOR NO.: 1
ENTER TARGET SOURCE LEVEL (db): 165
ENTER GRID SPACING (nm): 5
```

One map is produced for each time step in the interval specified. A map of acoustic coverage is displayed for the sensor number (sensor numbers may be obtained by using option LSEN) indicated against a target radiating noise at the source level indicated. The grid spacing indicates the vertical and horizontal distance between points on the map when probability of detection is evaluated.

The output produced by this option is illustrated in Chapter VI, Figures VI-1 and VI-2. The center indicates the sensor position. The symbols indicate the probability the sensor would detect the target if the target were in that grid position according to the following table:

TABLE III-6

SYMBOL DEFINITIONS IN PDSEN AND PDSTEP

Symbol	Probability Range
*	0.95-1.00
9	0.85-0.95
8	0.75-0.85
7	0.65-0.75
6	0.55-0.65
5	0.45-0.55
4	0.35-0.45
3	0.25-0.35
2	0.15-0.25
1	0.05-0.15
blank	0.00-0.05

Option PDSTEP

The option PDSTEP displays the acoustic coverage or localization coverage for either a sensor group or the entire screen in terms of a detection probability map and (optionally) a localization map. The detection probability map is in effect a composite PDSEN map for several sensors. A typical command sequence follows:

```
SELECT MODE (HELP GIVES LIST): PDSTEP
ENTER START,STOP STEPS (0 -  0)0,0
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER THE MAP LABEL:ENTIRE SCREEN
DO YOU WANT INFORMATION MAPS (Y OR N):Y
ENTER TGT NOISE INDEX   LEVEL (DB) (0=EXIT): 1,165
ENTER TGT NOISE INDEX   LEVEL (DB) (0=EXIT): 4,140
ENTER TGT NOISE INDEX   LEVEL (DB) (0=EXIT): 0
ENTER GRID SPACING(nm): 5
ENTER SAMPLE TIME (minutes): 15
```

The time step range must be within the time steps of the sensor file. Maps are produced for each time step in the range. Here only one time step is indicated.

The group number for the maps must be specified. Group numbers are given in the option LSEN output. Here we are depicting coverage for the entire screen.

A label may be input which will appear above the map. Next, the program asks whether you want information maps. These depict the degree to which the target would be localized if it were at that grid point.

Next, the program asks for target noise indices and levels. Up to 10* of these may be specified. The grid spacing is the vertical and horizontal distance between grid points, 5 nm in this case. Each grid point is indicated by a single symbol. Finally, the user inputs the sample time. This is the period of time over which the sensors were looking. The probability that each sensor actually looked in that direction is a function of the sample time and its scan time (found in LSEN output).

As a second example, the option PDSTEP is used to print a probability of detection map for the sensors in group 1:

```
SELECT MODE (HELP GIVES LIST): PDSTEP
ENTER START,STOP STEPS (0 -  0)0,0
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 1
ENTER THE MAP LABEL: GROUP 1
DO YOU WANT INFORMATION MAPS (Y OR N):N
```

```
ENTER TGT NOISE INDEX   LEVEL (DB) (0=POPOUT): 1,165
ENTER TGT NOISE INDEX   LEVEL (DB) (0=POPOUT): 0
ENTER GRID SPACING: 5
ENTER SAMPLE TIME (MINUTES): 15
```

No localization map is asked for in this case.

In the probability coverage output, the symbols correspond to the ones shown in Table III-6. In the localization coverage output, the symbols correspond to half the radius of an equivalent circular SPA (a SPA is a 2-sigma estimate of target position). Wherever there is a sensor that is turned on, there appears on the map a label that indicates the sensor type: P, A, or L. If several sensors are located close to the same grid point, the type of the last one in the LSEN list will be printed.

The PDSTEP option is useful to examine coverage for groups or the entire screen under alternative assumptions about target noise.

Option CDP

This option computes the cumulative detection probability performance by a sensor group or the entire screen against a selected set of targets. This option requires a PROP file, a sensor file, and at least one target file. A typical command sequence follows:

```
SELECT MODE (HELP GIVES LIST): CDP
ENTER START, STOP STEPS(1 - 3): 2,3
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER STEPS OF FLOW (>=0): 0
ENTER TARGET FILE NO. : 2
ENTER TARGET FILE NO. : 1
ENTER TARGET FILE NO. : 0
ENTER NO. OF POINTS PER FLOW (1,9,25 OR 49): 1
```

The CDP will be computed for every time step in the range specified. Note that the current time of the problem must be at least time step 1. As in PDSTEP, the program will compute CDP either for a sensor group or the entire screen as the user specifies.

Next, the user must specify the number of steps of flow. This means for each target additional delayed copies may be run starting at the same initial relative position, but each one time step later. For instance, if steps of flow is set to 2, one target copy is started at time step zero, one target copy is started at time step 1, and one target copy is started at time step 2. The input of zero steps of target flow implies only one copy of the target. The flow provision allows one to offset the uncertainty in target position and is particularly valuable if sensors are turned on and off during the cumulative time period. It corresponds to averaging over the arrival time of the target.

The CDP calculations are performed for each target specified. Any target loaded may be specified.

Finally, the user is asked to specify the number of points per flow. Each target has a probability distribution associated with it which is modeled as a bivariate normal probability distribution. The bivariate normal probability distribution is divided into a grid structure so that there are as many cells as the number of points per flow the user specifies, and each cell has equal probability of containing the target. Next, the mean position within each cell is assumed to be the starting point for a target and CDP is calculated against each point. The CDP for the target or flow is the average over each of these. The first point is always the center of the distribution. In the above example, that is the only point. See Chapter VI for other examples.

Option CDPL

This option computes the cumulative detection and localization performance by a sensor group or the entire screen against a selected set of targets. An environmental/sensor contour file, a sensor file, and at least one target file must be loaded to exercise this option.

A typical command sequence is as follows:

```
SELECT MODE (HELP GIVES LIST): CDPL
ENTER START, STOP STEPS(1 -  3): 2,3
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER STEPS OF FLOW (>=0): 0
ENTER TARGET FILE NO.  (1-99): 1
ENTER TARGET FILE NO.  (1-99): 2
ENTER TARGET FILE NO.  (1-99): 0
ENTER NO. OF POINTS PER FLOW (1,9,25 OR 49): 1
```

The first time step specified must be at least 1. A CDP header and localization header will be produced for each time step in the specified range.

The group number entered may be either the index of a sensor group or a 0 if the entire screen is to be used in CDP calculations. The number of steps of flow, target file number, and number of points per flow are as in option CDP above. Output from CDPL is shown in Chapter VI.

Option MAP

This option computes the information contained in the CDP option and also displays the target prior and/or posterior probability distribution that results from the sensor screen search being modeled. An environmental/sensor contour file, a sensor file, and at least one target file must be loaded to select this option. A typical command sequence follows:

```
SELECT MODE (HELP GIVES LIST): MAP
PRINT PRIOR DISTRIBUTION (Y OR N): Y
PRINT POSTERIOR DISTRIBUTION (Y OR N): N
ENTER GRID SPACING: 2.5
ENTER START, STOP STEPS(1 -  3)2,3
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER STEPS OF FLOW (>=0): 2
ENTER TARGET FILE NO.  (1-99): 1
ENTER TARGET FILE NO.  (1-99): 0
ENTER NO. OF POINTS PER FLOW (1,9,25 OR 49): 1
```

Most of these inputs have been described under option CDP. Here, in addition to the information produced by option CDP, the user has asked to display the target probability distribution prior to the search at each time step.

Option MAPL

This option computes and displays the information contained in the CDPL option and also displays the information maps, and the target prior and/or posterior probability distribution maps that result from the sensor screen search being modeled. An environmental/sensor contour file, a sensor file, and at least one target file must be loaded before this option is selected. A typical command sequence follows:

```
SELECT MODE (HELP GIVES LIST): MAPL
PRINT PRIOR DISTRIBUTION (Y OR N): N
PRINT POSTERIOR DISTRIBUTION (Y OR N): Y
ENTER GRID SPACING: 1.0
ENTER START, STOP STEPS(1 -  3)2,3
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER STEPS OF FLOW (>=0): 0
ENTER TARGET FILE NO.  (1-99): 1
ENTER TARGET FILE NO.  (1-99): 0
ENTER NO. OF POINTS PER FLOW (1,9,25 OR 49): 1
```

These inputs correspond to the ones in the options CDP and MAP. The output produced by this sequence is in Chapter VI.

On the localization map the number in each cell is the average one-sigma radius of an equivalent circular SPA. Alternatively, twice the number in the cell is the average radius of the circular SPA within which you would expect to have the target localized.

Option HELP. Typing HELP will result in a display of the list of valid options.

```
SELECT MODE (HELP GIVES LIST): HELP
INIT TSTEP POSIT MARGE BEAR COMI OUTPUT
DONE LLOSS LCON LPIM LSEN LTAR
ULOSS UCON UPIM USEN UTAR
PDSEN PDSTEP CDP CDPL MAP MAPL
```

CHAPTER IV

DATA FILE STRUCTURE AND CREATION

This chapter describes the data files which are used in the operation of the SCREEN program. Both the contents and the procedure for creating each file are described. In this chapter it is assumed that the user knows how to access the host computer and begin execution of the SCREEN program.

Note that in normal repetitive use these data files are already available on file, and so the procedures described in this chapter may be passed over by the occasional user.

An extensive example of data file creation is given in Chapter V. Reference is made to that chapter for examples of output produced by the steps outlined here.

Two notational conventions wll be used without further comment, namely, an asterisk (*) denotes compiler parameters that can be altered in the source code by changing the corresponding parameter variable, and user responses to program prompts are underlined.

General Remarks

This section gives some general remarks about data file structure.

File declaration. When the user executes SCREEN, he will be asked to specify or create the data files used by the SCREEN program. There are three types of files involved, each identified by a number 1 to 99. They are the following:

(1) The environmental/sensor contour file (denoted 'PROP' for propagation data) contains all of the parameters associated with the acoustic environment and certain contours which describe sensor performance. The file may contain up to 10* propagation loss curves together with the associated reverberation curves (if the propagation loss is for an active sensor) and up to 20* sensor aspect contours.

(2) The sensor file (denoted 'SENS') describes each of the acoustic sensors used in the ASW screen together with a set of time-dependent sensor parameters over the full period of the problem.

(3) The target file (denoted 'TARG') describes the acoustic characteristics and motion assumptions for a target penetrator. Up to 10* target noise levels are indexed for each target.

File indices. Each sensor in the sensor file uses three indices which reference the appropriate portions of the PROP contour file and the target file. The first index indicates which propagation loss curve from the PROP contour file applies at this time step for this sensor. The second index specifies which sensor aspect contour in the PROP contour file applies to this sensor at this time step. The third index indicates which target radiated noise level index the sensor is trying to detect at this time step. The same noise index is used to identify interfering noise from the HVU and other sensor platforms. The results of SCREEN are meaningful only if these three sets of indices have been consistently applied.

The consistent application of these three indices is a critical factor in using SCREEN. Prior to beginning data input into these files, one should make initial index assignments.

The selection of environment curves, sensor contours, and target noise levels depends on the types of sensors and engagements that are to be modeled. At the outset, the SCREEN user should specify the candidate sensors and threat targets. From these, operating modes and acoustic detection modes may be established. The sensor frequencies

and operating depth determine (together with the target operating depth and assumed acoustic environment) the PL and reverberation curves. If two frequencies are close, it may be possible to double up and use the same PL curve. If a depth game is to be played (e.g., search both shallow and deep), then sets of curves are needed for each depth (in the sensor file the choice of PL curve can be changed at each time step if desired, so it is possible to emulate search at different depths). Different assumed target depths also may require separate PL curves (the program at present does not explicitly consider target depth). Both passive and active sensors may use the same environmental curves--the passive sensor simply ignores the reverberation data.

Required files. Some program options do not require all three files. Table IV-1 lists the minimum required file declarations for the various options. More details regarding this can be found in Chapter III where the individual options are discussed.

Only one PROP and SENS file may be declared (loaded) for each selection of program options, but multiple TARG files may be declared. A particular file is declared by stating its number. In the user directory, the files are stored under names that include the identifying number. For example, PROP01 is the environmental/sensor contour file identified as number one, SENS03 is the sensor file identified as number three, and TARG39 is the target file identified as number 39. File numbers from 1 to 99 are valid.

When a data file is declared at the start of a run or in the INIT option, the program loads the file with the corresponding identifying number if it exists in the user's directory. If the file is not found in the user's directory, the program branches to a subprogram which requests user input to create the file which is then stored for future reference. If the user wishes to overwrite an existing file, he must first delete it. In the simplest mode of operation, SCREEN uses existing files and the user does not need to know how to create the files. If a zero is entered for a file number, no file will be loaded. As shown in Table IV-1, many options do not require all types of data files.

File protection. In general, the data files are not protected from alteration by the program. Certain program options will cause changes in the data files. These are listed in Table IV-2. Unintentional changes to data files are likely to produce catastrophic errors, and in particular, to alter the contents of laboriously constructed files. The use of backup copies of valuable files or system level protection against alteration will prevent accidents of this sort. Also if complicated files are created using option COMI, see Chapter III, then if they are destroyed they may be recreated simply.

TABLE IV-1

MINIMUM FILE DECLARATIONS FOR STATED OPTIONS

Option	Minimum File Declarations
TSTEP	SENS or TARG
POSIT	TARG
MARGE	TARG
BEAR	TARG
LLOSS	PROP
LCON	PROP
LPIM	SENS
LSEN	SENS
LTAR	TARG
ULOSS	PROP
UCON	PROP
UPIM	SENS
USEN	SENS
UTAR	TARG
PDSEN	SENS,PROP
PDSTEP	SENS,PROP
CDP	PROP,SENS,TARG
CDPL	PROP,SENS,TARG
MAP	PROP,SENS,TARG
MAPL	PROP,SENS,TARG

TABLE IV-2

PROGRAM OPTIONS THAT ALTER DATA FILE CONTENTS

Option	Files Affected	Effect
TSTEP	SENS or TARG	(1) If the new time step is greater than the current time of the SENS or TARG files, then the files are <u>extended</u> to the new time. The previous information contained in the files is not lost. (2) If the new time step is less than the current time of the SENS file, the current time of the file is truncated to this time. All information is lost after the new time step. (3) If the new time step is less than the current time of a TARG file, <u>no action is taken</u>; the TARG file is unaffected. (4) If the new time step is the same as the current time of a SENS or TARG file, no action is taken for that file.
POSIT MARGE BEAR	TARG	The target file specified in the option is altered.
ULOS	PROP	The specified propagation loss or reverberation contours are altered to the new declared values. It is possible to exit this option with no changes, if desired.
UCON	PROP	The specified sensor contours are altered to the new declared values. It is possible to exit this option with no change, if desired.
UPIA	SENS	Specified options alter previous file values. It is possible to exit this option with no change, if desired.
USEN	SENS	Specified options alter previous file values. It is possible to exit this option with no change, if desired.
UTAR	TARG	Specified options alter previous file values. It is possible to exit this option with no changes, if desired.

PROP File -- Environmental/Sensor Contour File

The environmental/sensor contour (PROP) file contains parameters associated with the acoustic environment and sensor hardware characteristics that in general do not change with time. These include:

(1) up to 10* propagation loss curves, each with omnidirectional ambient noise,

(2) the associated reverberation curves (active sensors only), each with sonar source level and delta RD for the reverberation limited case,

(3) up to 20* sensor delta noise contours, each with directivity index,

(4) up to 20* sensor beam width contours,

(5) up to 20* lambda and sigma tables for bearing measurements,

(6) up to 20* lambda and sigma tables for range measurements.

The description of these quantities follows.

Environmental data. The environmental data are contained in 10* associated groupings of data that are identified by number. A given numbered grouping contains the following information:

Propagation loss (db) tabulated at 1* mile intervals out to 120* miles,

Omnidirectional ambient noise (db) for the environment,

Active reverberation curve (db) tabulated at 1* mile intervals out to 120* miles,

Change in recognition differential for reverberation limited operation (as compared to noise limited operation),

Active source level (db) associated with the reverberation curve.

If a grouping of environmental data refers to a passive sensor, then the reverberation curve and associated data can be omitted.

The environmental file always contains records for each of the 10* groupings. Until a grouping is given particular values, it contains default values. As described above, every sensor in the sensor file indexes an associated environmental group number which determines the data that apply to that sensor at that time step.

Sensor aspect contours. The sensor contours in the PROP file contain information that tends to be hardware related and thus reasonably constant for a given sensor type. The data are groupings numbered 1, ..., 20* and called 'contour number' in the SENS file. A given numbered grouping contains the following information:

Directivity index (DI). This gives the array discrimination against omnidirectional ambient noise. The DI is used only to reduce the omnidirectional ambient noise associated with a propagation loss curve.

Two contours specify sensor response as a function of relative bearing:

Delta-self-noise as a function of relative bearing. This is the effect at the beamformer output of sensor platform noise. A nominal value of self-noise is included with each sensor: the total self-noise at a given relative bearing is the algebraic sum of the nominal self-noise (given in the SENS file) and the delta self-noise as given in this contour.

Beamwidth of receiving array as a function of relative bearing. This beamwidth is the angle between the 3 db down points on the main lobe. In general, this will vary with relative bearing. The beamwidth in a given direction is used in determining total background noise due to the presence of other screen units. The interference of the sensor platform itself is treated under self-noise.

The signal excess contours specify the statistical properties (standard deviations and mean time between independent samples), two each for bearing and range measurements. These are expressed as a function of the mean signal excess (SE). They are identified as follows. It is assumed that sigma (B) for other beams is proportional to the beamwidths.

Bearing standard deviation as a function of SE. For a directional sensor, this is called the sigma(B) curve. This curve applies to a beam having a stated nominal beamwidth.

Bearing measurement relaxation time. This gives the mean time between independent bearing samples. This is called the lambda(B) curve.

Range standard deviation as a function of SE. For an active sensor, this gives sigma(R).

Range relaxation time. This gives the mean time between independent range samples. This is called the lambda(R) curve.

The contours of bearing and range standard deviation and relaxation time as a function of signal excess are used in the localization routines. If the program is only used for detection, these contours may be omitted.

Generally speaking, the accuracy of a bearing or range determination depends on the signal excess received from the target. This is reflected in the curve of sigma(B) versus mean signal excess. The curve applies to a particular beamwidth, generally taken to be a forward-looking beam for spherical and conformal arrays and a broadside (090 degrees) beam for wide aperture arrays and towed line arrays. The value of sigma(B) is assumed to be proportional to beamwidth, and so specifying it for some nominal beamwidth defines it for the others as well.

The signal excess contours are used by the program as follows: if the computed mean signal excess is less than the lowest value tabulated in the contour, then no localization is assumed (although detection is still permitted). A mean signal excess higher than the highest value tabulated uses this highest value. Thus, if one established a sigma(B) and lambda(B) versus signal excess contour with a single input value, such as illustrated in Figure IV-1, the effect would be: no bearing measurement possible for signal excess < 0 db, and bearings occur with sigma(B) = .5 degrees and lambda(B) = 15 minutes for any signal excess greater than or equal to 0 db.

Frequently it will be found difficult to obtain published values for sigma(B), etc., as a function of signal excess. In such cases, use of single entries is justified; the only necessity is to determine a cutoff value below which localization is not possible, and the values for sigma(B) and lambda above this cutoff.

The relaxation numbers refer to the mean time between independent samples of bearings or range. The program assumes an exponential process with a mean value determined by this input. Unfortunately, values for this are not easily obtained, as it is not normally included among the descriptive material on a sonar system. This is unfortunate because the data rate for independent bearing or range samples is obviously a very important parameter for use in assessing localization.

The sigma(R) and lambda(R) contours are handled (for active sonar)

in a manner analogous to sigma(B) and lambda(B). For active sonar, it is assumed that sigma(R) is constant with range, being related to the ability to measure arrival time rather than to geometric considerations.

FIGURE IV-1

```
                SIGMA BEARING NO.    1
               REFERENCE BEAMWIDTH   90

(DEGREES)
 0.50+.     .    .    ****************
     +!++++!++++!++++!++++!++++!++++!
    -15  -10   -5    0    5   10   15

                        SF

               LAMBDA BEARING NO.    1

(MINUTES)
  15.+.     .    .    ****************
     +!++++!++++!++++!++++!++++!++++!
    -15  -10   -5    0    5   10   15

                        SF
```

The sensor contours included in the PROP file reflect the sonar platform, array characteristics, frequency of operation, and the signal processing hardware (particularly beamformers):

(1) <u>Delta self-noise</u> is the change in self-noise as a function of relative bearing. This change comes about as the combined effect of changes in beamwidth and directional platform-generated noise. This contour is also used to depict "baffles" which effectively blank out sectors of

relative bearing. General remarks about U. S. sonars are as follows:

(a) Spherical arrays pick up ship-generated noise at certain relative bearings. These tend to change from ship to ship and with time. Usually, this type of noise is not modeled (it is assumed the ship can maneuver to avoid such lines). In addition, hull-mounted spherical arrays have a baffle area which isolates the sphere from the ship. This is modeled as very high self-noise (to eliminate detections "in the baffles") in the direction of the baffles.

(b) Conformal arrays also tend to pick up ship noise in the relative bearings that face the ship. This is also modeled as high self-noise in these directions.

(c) Towed line arrays will tend to have a fairly uniform self-noise field, although it will increase in the direction of the towing platform.

(2) Beamwidth for an array is a function of the array geometry and frequency of operation. Comments on the general types of sonar used in the U. S. Navy are as follows:

(a) Spherical arrays tend to have a constant beamwidth at all relative bearings that is proportional to the center frequency of operation.

(b) Conformal arrays (and to a lesser extent spherical) have a beamwidth that is narrowest in a forward direction and broadens as the relative bearing increases left or right.

(c) Wide aperture arrays have the narrowest beam perpendicular to the array baseline, usually at 90 degrees relative.

(d) Towed line arrays have a beam that is narrow at 90 degrees relative and broadens considerably for forward-looking beams.

(e) Omni sensors are nondirectional sensors. Enter a beamwidth of 360 degrees to specify an omni sensor. If the sensor is also ambient noise limited, an omni sensor may be defined by responding 'END' to the first request for delta self-noise and beamwidth. This sets delta self-noise to -100 and beamwidth to 360 degrees, the default values.

Creation of PROP Files

The environmental/sensor contour files are stored in the user directory under the names PROP01, PROP02, ..., PROP99. When INIT is being executed, either to start up the program or as an option, the user will be asked to specify which he wants to load with the following prompt:

```
ENTER ACOUSTIC DATA FILE NO. (1-99): 1
```

The program will search through the user directory for the indicated file, in this case PROP01. When it does not find it, the program will begin prompting the user for inputs.

Propagation loss input. The PROP file provides for the tabulation of up to 10* propagation loss curves, identified by numbers 1, ..., 10. Each curve corresponds to a particular environment, frequency, target depth, and receiver depth.

The first set of prompts allows one to input a propagation loss curve and its associated reverberation curve. Typing a zero for "PROP LOSS CURVE NO" causes the program to branch to the sensor aspect contour entries.

The prompts presented for inputting a propagation loss curve appear as follows:

```
ENTER PROP LOSS CURVE NO. (1- 10): 1
ENTER THE PROP LOSS CURVE LABEL: PROPLOSS#1
AMBIENT NOISE (db) :69
ENTER RANGE (nm) , PROP LOSS (db)  PAIRS
(ENTER PROP LOSS -200 TO DELETE RANGE ENTRY)
(ENTER 'END' TO POP OUT)
DATA POINT: 6,76
DATA POINT: 12,80
DATA POINT: 12,78
DATA POINT: 18,80
DATA POINT: 24,82
DATA POINT: 32,84
DATA POINT: END
```

The prop loss curve number is the index of this particular propagation loss curve. If the same index is input twice, the previous contents are lost and replaced in their entirety by the new curve data. The propagation loss curve label appears above the printout of the propagation loss curve in the LLOSS option and in the table produced by the LSEN option. It is used only as a label and can be left blank.

The next input is the omnidirectional ambient noise. This quantity is normally obtained from the same source as the propagation loss curves. The final input is a representative set of data points to set up the propagation loss curve. When all points have been input, type 'END' as shown to proceed to the next set of prompts. Unless another value is specified, the loss at 0 nm has a default value of 60 db. The prop loss is stored according to the value of range rounded to the nearest integer mile. If the range is outside of the bounds established in the program (0 and 120* miles) an error message will appear. Inputting a range a second time will correct the first entry. In the above illustration, the program assumes a propagation loss of 78 db at range 12 nm, which is a correction of the 60 db entered above. A propagation loss of -200 will delete the range entry. The program contains an interpolation routine that linearly interpolates between the input values. The highest range entered ends the look-up table. The recorded value for all larger ranges is the default, but is not accessed during the program.

Reverberation curve input. After an "END" has been typed, the remaining prompts assume an active sensor. To omit this part for passive sensors, the user enters a zero (0) for LS (active source level), and the program will skip the reverberation curve and request another propagation loss curve index. If a positive value of LS is entered, the program will ask for input of the reverberation curve associated with the propagation loss curve. The following prompts give an example of input of a reverberation curve:

```
ENTER ACT. SOURCE LEVEL AND DELT RD FOR REVERB(db) (0= EXIT)

LS (db) AND DELTRD (db): 235,1
ENTER REVERB CURVE LABEL: REVERB#1
ENTER RANGE (nm) , REVERB (db) PAIRS
ENTER REVERB -200 TO DELETE RANGE ENTRY
ENTER 'END' TO POP OUT
DATA POINT: 1,52
DATA POINT: 5,10
DATA POINT: END
```

The input is very similar to the input of a propagation loss curve.

The source level is the level of the signal emitted by the sensor. The quantity DELTRD is defined as:

$$DELTRD = RD(R) - RD(N)$$

RD(R) = Sensor recognition differential under reverberation limited operation (db)

RD(N) = Sensor recognition differential under noise limited operation (db) (this quantity is recorded in the SENS file).

The reverberation curve label appears above printouts of the reverberation curve: it may be blank. Finally, range (nm) and reverberation (db) are input followed by an 'END' to exit. Again, the default value at 0 (zero) range is 60 db.

Aspect contour input. After an entry of 0 (zero) to the 'Enter Prop Loss Curve No.' prompt, the user will input the sensor aspect contours. The first prompts are as follows:

```
ENTER ASPECT CONTOUR NO. (1-20): 1
ENTER THE ASPECT CONTOUR LABEL: ASPECT#1
ENTER DIRECTIVITY INDEX (db) : 9
```

The aspect contour number corresponds to the aspect contour index in the sensor file. The aspect contour label appears above the plot of the aspect contour in the LCON option and in the table produced by the LSEN option: it may be blank. The directivity index (DI) in (db) is the amount by which omnidirectional background noise is reduced because the sensor is listening in only one direction. This parameter is used only to reduce omnidirectional ambient noise in the sonar equation.

Next, the program will prompt for inputs of the actual aspect contour as given in this example:

```
ENTER BEARING(deg), DELTA SELF-NOISE(db), BW(+-3db) TRIPLES
(ENTER 'END' TO EXIT)
(ENTER DELTA SELF-NOISE = -100 TO DELETE ENTRY
DATA POINT: 0,5,36
DATA POINT: 20,5,48
DATA POINT: 30,0,12
DATA POINT: 60,0,6
DATA POINT: 120,0,6
DATA POINT: 170,0,48
DATA POINT: 180,0,36
DATA POINT: 190,0,48
DATA POINT: 240,0,6
DATA POINT: 300,0,6
DATA POINT: 330,0,12
```

DATA POINT: 340,5,48
DATA POINT: END

The bearing is the relative bearing in degrees clockwise from the sensor's bow. The delta self-noise is the adjustment to effective self-noise of the sensor for that relative bearing. Self-noise is measured at the beamformer output, and includes the directional discrimination of the sensor. The beamwidth is the width of the main lobe between the 3db down points. These triples are interpolated to form the aspect contour which is tabulated at 6* degree intervals, centered at 0 degrees, 6 degrees, -6 degrees, etc. Bearing entries are modulo 360 degrees, so negative bearings are allowable. They are converted to the corresponding bearings in the range [0,360).

Signal excess contours. After entering 'END' in the 'triple' prompts, the user will be presented with the following prompt:

ENTER REFERENCE BEAMWIDTH (+-3 db DOWN):6

The reference beamwidth is used in localizations. This is the beamwidth for which the next group of curves applies. A different beamwidth will result in proportional adjustment of the curves.

The next set of prompts create the bearing sigma and lambda contours. They appear as follows:

ENTER SE (db),SIG.BRG(deg),RELAX.TIME (min):-10,15,30
ENTER SE (db),SIG.BRG(deg),RELAX.TIME (min):-5,10,5,22.5
ENTER SE (db),SIG.BRG(deg),RELAX.TIME (min):0,6,15
ENTER SE (db),SIG.BRG(deg),RELAX.TIME (min):5,4.5,15
ENTER SE (db),SIG.BRG(deg),RELAX.TIME (min):10,3,15
ENTER SE (db),SIG.BRG(deg),RELAX.TIME (min):15,3,15
ENTER SE (db),SIG.BRG(deg),RELAX.TIME (min):END

The program asks the user to input the signal excess, the standard deviation in the bearing at that signal excess, and the average time in minutes between independent observations (= 1/lambda). This curve is used in calculating localization information. The data request is terminated by entering 'END'. If no curve is to be input, reply 'END' to the first prompt. Replying 'END' to the first prompt is an effective way to describe omnidirectional sensors.

Next, the program will present these prompts:

ENTER SE (db), SIG.RANGE (yds), RELAX.TIME (min):-10,40,30
ENTER SE (db), SIG.RANGE (yds), RELAX.TIME (min):-5,30,22.5
ENTER SE (db), SIG.RANGE (yds), RELAX.TIME (min):0,10,15

```
ENTER SE (db), SIG.RANGE (yds), RELAX.TIME (min):5,0,15
ENTER SE (db), SIG.RANGE (yds), RELAX.TIME (min):10,0,15
ENTER SE (db), SIG.RANGE (yds), RELAX.TIME (min):15,0,15
ENTER SE (db), SIG.RANGE (yds), RELAX.TIME (min):END
```

Here the program is asking for input of signal excess, the standard deviation in a range measurement taken at that signal excess, and the expected time in minutes between independent range estimates. This curve is also used in localizations for active sensors. The data request is terminated by entering 'END'. If no curve is to be input, reply 'END' to the first prompt.

Finally, the following prompts will appear:

```
ENTER ASPECT CONTOUR NO. (1-20): 0
ENTER SENSOR FILE NUMBER (1-99):
```

When a zero is entered for aspect contour number, the program will continue on to ask for the sensor file number, discussed in the next section.

Environmental/sensor contour files can be modified outside of INIT by using the ULOSS and UCON options. These are discussed in Chapter III.

Simplified input of PROP files. The PROP files are designed so that the user can "pass over" unwanted detail. Specifically, for the simplest file creation, the following is worth noting:

(1) The propagation loss (PL) and reverberaton curves are obtained by linear interpolation between values input by the user. There is a default value of 60 db at 1 nm (unless changed by input). Hence, the simplest PL curve is obtained by inputting a single line such as the following:

```
ENTER RANGE (nm) , PROP LOSS (db) PAIRS
(ENTER PROP LOSS -200 TO DELETE RANGE ENTRY)
(ENTER 'END' TO POP OUT)
DATA POINT: 40,100
DATA POINT: END
```

This produces a linear PL curve between 60 db at 1 nm and 100 db at 40 nm and no detection possible beyond 40 nm.

(2) Omitting the active reverberation curve simply means

that "reverberation is not important," i.e., an active sonar is presumed to operate under noise limited conditions.

```
ENTER ACT. SOURCE LEVEL AND DELT RD FOR REVERB(db)  (0=
POP OUT)
LS (db) AND DELTRD: 130,0
  ENTER REVERB CURVE LABEL: Active Surface
  ENTER RANGE (nm) , REVERB (db) PAIRS
  ENTER REVERB -200 TO DELETE RANGE ENTRY
  ENTER 'END' TO POP OUT
  DATA POINT: END
  ENTER PROP LOSS CURVE NO. (1- 10): 0
```

(3) Multiple PL curves are available if desired, but need not be used (however, at least one PL curve must be defined).

(4) Any 'contours' that are not defined are utilized with given default values that effectively remove them from consideration.

(a) The relative bearing contours can be set to a constant value by a one line input (any relative bearing is all right) such as:

```
ENTER BEARING(deg), DELTA SELF-NOISE(db), BW(+-3db)
 TRIPLES
(ENTER 'END' TO POP OUT)
(ENTER DELTA SELF-NOISE = -100 TO DELETE ENTRY
DATA POINT: 90,3,5
DATA POINT: END
```

Warning: if the beamwidth contour is not defined, it will default to zero, with the effect that there will be no interfering shipping noise (which uses beamwidth in the calculation).

(b) The SE contours are used for localization. If the localization is not employed, they may be omitted. The simplest nontrivial input of SE contours requires one line of input, namely, a signal excess value, a bearing value, and a value for lambda. All mean signal excess values above the input signal excess will use the input values for bearing and lambda while values below the input signal excess will have zero bearing and lambda.

If in doubt, the contents of the PROP file can be reviewed using the LLOSS or LCON options.

SENS File--Sensor File

Sensor file parameters describe each of the acoustic sensors and high value units used in the problem. The parameters that may vary with time are described in the SENS file, whereas the constant parameters that depend on hardware design are described in the sensor contours contained in the PROP files.

The number of sensors can only be changed when the file is at time step zero. Sensors may be turned on and off at each time step, but the total number of sensors is constant throughout the problem. Thus, if it is planned to add sensors at some time, these should be included at time step 0 and turned off if not yet employed.

Only one SENS file may be declared at a time, but within that file many sensors and other task force units may be included.

The sensor files are stored in the user directory under the names SENS01, SENS02, ..., SENS99. When INIT is executed automatically at the start of the program run or later on as an option, SCREEN will ask the user to specify which file he wants to load with the following prompt:

ENTER SENSOR FILE NUMBER (1-99): 1

The program will search through the user directory for the specified file, in this case SENS01. When SCREEN does not find SENS01, it will help the user create the initial file data (for time step zero). Changes to the file are done by using program option USEN, described in Chapter III.

File name and time parameters. If no SENS file is found, the user is prompted to provide the inputs necessary to construct one. The first three prompts are:

ENTER SENSOR FILE NAME:SONOBUOY FIELD
ENTER START DTG (DD.HH.MM): 00.00.00
ENTER DELTA T (hrs) :.25

The name of the sensor file will appear above LSEN output. The start time for the problem is then entered as a two-digit day number, a two-digit hour number, and a two-digit minute number. Finally, the user is asked for DELTAT in hours. Here, fifteen minutes is input as 0.25 hours. This DELTAT represents the length of a time step, and will be used to time step the screen problem. The program assumes that a constant time step is used throughout the encounter.

PIM designation. Next the following prompts will appear:

```
ENTER INITIAL PIM COORD (X,Y) (nm): 0,0
ENTER INITIAL PIM SPEED (kts),HEADING (deg): 10,0
```

Here the initial PIM position is at the origin and it is moving north at 10 knots. Throughout this volume heading is in degrees clockwise from north.

HVU definition. Next the HVU parameters are defined.

```
ENTER THE HVU NO. (1-  5): 1
ENTER THE HVU LABEL (ENTER $$ TO DELETE): HVU#1
ENTER HVU INITIAL COORDINATES (nm): 0,0
ENTER HVU SOURCE INDEX AND LEVEL (db)(0=POP OUT): 1,165
ENTER HVU SOURCE INDEX AND LEVEL (db)(0=POP OUT): 0
ENTER THE HVU NO. (1-  5): 0
```

Up to 5* HVUs may be input with this option. We enter HVU index of 1. The HVU label is used only for printouts. The significance of "$$" is explained in option PIM described in Chapter III. Basically, this is used to remove an HVU that was previously defined. The HVU is assumed to follow PIM.

The SCREEN program treats HVUs as noise makers which interfere with the detection performance of the other screen units. The levels of noise interference are indicated in the next user responses. There are 10* possible distinct noise indices, corresponding to different sensor acoustic performance charactertistics (narrowband lines, broadband, active, etc.). For a given use of SCREEN, the user should establish the identity of each index and then input at this point the level of interfering noise this HVU contributes for that index. Note that an entry of zero (0) is not equivalent to no noise since decibel units are used. Any indices which are not explicity declared are given default values which are interpreted as no interference for that index. Entering an HVU number of 0 causes the input to go on to sensor definition.

Sensor definition. Sensors are defined and numbered sequentially from 1 to the maximum number of sensors allowed (currently 40*). These are the essence of the SENS file, and therefore their input is described in some detail.

Description of a given sensor is defined by the following prompts and responses:

```
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): Y
```

If the answer to this prompt is 'Y', then the program requests data for a new sensor. The sensor is added to the end of the existing list of sensors (if any) and numbered accordingly. Sensor order can be changed with option USEN described in Chapter III; the sensor number determines the sequence in which sensors are listed in option LSEN.

If the answer to the prompt is 'N', then the program exits sensor file initialization and prompts the user to declare target files (see below).

```
ENTER SENSOR LABEL: ($$=DELETE): SENSOR#1
```

The sensor label appears in the LSEN listings <u>unless</u> the sensor label is '$$', in which case the sensor is <u>omitted</u> from listings and in addition is considered to be 'off'. Sensor positions that are reserved for future use can be defined with label '$$' and type of sensor specified '0' (off) which can then be changed by option USEN when it is time to use them. (If the sensor is not specified as 0 (off), and is later turned on by removing the '$$' with a name, subsequent detection and localization performance calculations will treat the sensor as being on all the time. If there is any uncertainty as to which sensors are being evaluated at any time step, the answer is quickly determined by looking at the LSEN printout for that time step.)

```
ENTER TYPE OF SENSOR (P, A, L, 0): P
ENTER INITIAL COORDINATES (X,Y) (nm): 0,0
ENTER SPEED (kts) AND HEADING (deg): 10,0
ENTER NOISE RD AND NOMINAL SELF-NOISE LEVEL (db): 10,30
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=): 0
ENTER PL NO., ASPECT NO.,TGT NOISE NO.: 1,1,1
ENTER LAMBDA (#/hr) AND SIGMA (db): 1,9
ENTER SCAN TIME AND INTEGRATION TIME (min.).1,5
ENTER PROBABILITY SENSOR IS AVAILABLE(RANGE 0-1): .95
```

The identity of these items is as follows:

<u>Sensor type:</u> P (Passive Sensor)

A (Active Sensor)

L (Active Line Array)

0 (Sensor is 'off')

The 0 is used to allow definition of a sensor that may be used in a subsequent time step. An '0' sensor is listed in LSEN unless its label is '$$' as noted above.

RD: Sensor recognition differential (for an active sensor, it is the RD that applies under noise limiied operaton, RD(N)).

Nominal self-noise: Nominal self-noise at the beamformer output. When this quantity is added algebraically to the self-noise contour value (in PROP file), it gives self-noise at a given relative bearing.

Sensor noise index and level: There are 10* noise indices which are used to define target radiated noise, self-noise, and interfering noise. A single index corresponds to a particular sensor detection mode, frequency band, etc. If this sensor radiates noise which can interfere with other search platforms, the noise levels are entered here (in the same way as described above for HVUs). Self interference is handled in the self noise above, not here.

PL no.: Propagation loss contour number for this sensor. This defines the environmental contours contained in the PROP file to be used for this sensor.

Aspect no.: Sensor contour number for this sensor. This defines the set of sensor contours contained in the PROP file that apply to this sensor.

Target noise no.: The noise index that corresponds to this sensor. The sonar equation computation of SE uses this index to determine target radiated noise as well as interfering noise from other sensor platforms and HVUs.

Lambda: Number of independent looks at random signal excess per hour for this sensor.

Sigma: Random signal excess standard deviation.

Scan time: The mean time between looks at a given part of the sensor coverage region (minutes).

Integration time: The sensor integration time (minutes).

Probability of availability: Probability that sensor is operational when the encounter occurs (this has to do with system reliability).

Each of these items can vary with time (except the sensor label). If changes are desired at a given time step after the SENS file has been created, option USEN is used. The specific use of these

parameters in describing sensor performance is given in Chapter II of reference [a].

Sensors, subgroups, and groups. A typical screen is composed of a number of logically similar collections of sensors. The SCREEN program takes advantage of this fact by allowing the user to form sensor subgroups and groups by which a screen can be established by moving around blocks of sensors rather than defining every one individually.

There are three levels of aggregation in SCREEN: the individual sensor, sensor subgroups, and sensor groups. The order and manner of definition of these is as follows:

(1) Define the sensors in a subgroup. The first sensor defined is the "kingpin." Its coordinates are used to define the location of the subgroup. Other sensors in a subgroup are defined relative to the kingpin. A subgroup can consist of any number of sensors up to the program limitations on total numbers of sensors. Since the sensors are numbered in order of input, the first sensor in a subgroup is also the first listed for that subgroup on LSEN listings (unless the order is altered by USEN).

(2) Make copies of the defined subgroup to form a group. To make a copy, it is only necessary to indicate the new coordinates of the kingpin. Other sensors are then placed in the same relative position in the screen.

(3) Make copies of the group. The coordinates of the kingpin of the first defined subgroup become the coordinates of the group kingpin. Copies of the group are made by specifying the coordinates of the group kingpin. All other sensors in the group are placed in the proper position in the screen relative to the kingpin.

This process of creating sensor groups is only possible at the time when the kingpin sensor is defined. Subsequently, the program loses track of kingpins and subgroups. Group identities are retained for another purpose: they define a spatial correlation between sensors, and are used for displays of group performance in the DISTEP, CDP, CDPL, MAP, and MAPL options described in Chapter III.

After defining a sensor with the above sequence, the next prompt is:

MORE SENSORS IN SUBGROUP OF GROUP (Y OR N): N

Here, a response of 'N' causes the computer to go to the next level. If a 'Y' had been entered, the user would first be asked to indicate definitions of the group correlations for the group being created and then asked to enter definition of all additional sensors in the subgroup.

A correlation coefficient is input for each sensor group. In subsequent calculations, the detection probabilities are calculated using the correlation number to interpolate linearly between complete correlation and complete independence of the sensors in the group. Specifically, if p(i) and p(d) denote the probabilities of detection assuming complete independence and complete correlation, respectively, then the probability of detection for the group with correlation number r is p = (1-r) p(i)+rp(d).

When all sensors in the subgroup have been input, the program will prompt:

ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): Y
ENTER GROUP CORRELATION (RANGE 0-1): .5

The group correlation question is only asked if the subgroup consists of one sensor. If the subgroup consisted of more than one sensor, this question would have been answered prior to entering the parameters of the second sensor in the subgroup.

If a copy is to be made, the program will prompt:

ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: 0,15

The first defined sensor in a subgroup becomes the "kingpin" for that subgroup. All subsequent subgroups are placed relative to the coordinates of the new position of this first sensor.

After all copies of the subgroup have been made, the entire group may be copied following the prompt:

ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): N

The creation of new copies of groups is similar to subgroups:

MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -10,5
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): N

When group copying is done, the program returns to the sensor definition (starting a new subgroup and group).

DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): N

The answer of 'N' to the above prompt completes construction of the sensor file at time step zero. The sensor file is completed using option ISTEP to advance it and option USEN to modify parameters either at time step 0 or later. Chapter V contains an example of the recursive use of ISTEP and USEN to complete the definition of a sensor file.

The composition of sensor groups can be altered in USEN. The above procedure permits groups to be composed of copies of only one type of subgroup. A more complex group structure can be obtained by forming temporary groupings in INIT and then combining them into one group using USEN. As far as the program logic is concerned, distinct groups have distinct identification numbers (listed in LSEN). This number can be changed as desired in USEN. In particular two groups can be combined by giving them the same group number or a single group may be split by giving part of the sensors a distinct group number. See Chapter V for an example of combining groups.

TARG File--Target File

Target file parameters describe the position, course, and speed of a target and also its various radiated noise levels. Entries are initially made for time step 0 and then the TSTEP and UTAR options are used to expand the target file to include information and describe the approach tactics at additional time steps.

Target files are named TARG01, TARG02, ..., TARG99. Up to 99 target files may be stored on disk simultaneously and multiple target files may be loaded into the program at one time. The user specifies a number for each target file he wishes to load.

ENTER TARGET FILE NO. (1- 99): 1

Here the user specified target file number 1. If there is no file TARG01 in the user's directory, the program will provide the following prompts to create the time zero target file:

```
ENTER DELTA T (hrs):  .25
ENTER TARGET LABEL: TARGET#1
ENTER INITIAL TARGET COORD (X,Y) (nm): 0,20
ENTER INITIAL TARGET SPA PARAMETERS
   2 SIG S-MAJ AXIS,S-MIN AXIS(nm), BRG OF MAJ(deg): 5,2,0
ENTER TARGET MOTION PARAMETERS
     TARGET VEL CHANGE RATE (#/hr): 1
     MEAN TARGET SPEED (kts), HEADING (deg): 10,180
     STANDARD DEV IN TARGET SPEED, HEADING: 1,5
ENTER TGT NOISE INDEX AND LEVEL (db)(0=):  1,135
ENTER TGT NOISE INDEX AND LEVEL (db)(0=):  0
ENTER TARGET FILE NO. (1- 99): 0
```

Here DELTA T is entered in hours. The user will not have to enter DELTA T if a sensor file has been loaded: the DELTA T associated with the sensor file will be used and this prompt will not appear. The DELTA T entered here must be the same as that in any sensor file defining a screen which this target is to approach. When the approach is to be evaluated, the sensor file and target file must be loaded concurrently, and then the program will refuse to load any target file with DELTA T different from the one in the sensor file. The label for the target will appear in LTAR listings and can be blank.

The initial position (SPA center) of the target is entered in nm. Next is entered the target SPA parameters: the 2-sigma semimajor axis length in nm, the 2-sigma semiminor axis length in nm, and the angle of the major axis in degrees clockwise from north.

The target motion parameters are entered next. First is the

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expected number of times the target will change velocity in one hour. The next parameters are the target speed in kts and the target heading in degrees clockwise from north. The final target motion parameters are the standard deviations in target speed and heading. Speed and heading are assumed to be normally distributed so that the mean and standard deviations completely specify their distributions.

The final set of inputs are indexed target radiated noise levels in (db) units. Up to 10* of these may be input. The sensor file will contain a noise index indicating the target noise level it is trying to detect.

As with the sensor file, this completes the definition of the target file at time step zero. The rest of the approach tactics are entered using options UTAR and TSTEP, described in Chapter III, as illustrated in Chapter V.

Exit from target file construction is made by entering a zero target file number. The SCREEN program then requests the specification of output device and then proceeds to the main option table.

CHAPTER V

SAMPLE SCREEN PROBLEM: DATA FILE PREPARATION

This chapter gives the sequence of steps involved in setting up a screen problem. The screen of this example protects a carrier. The screen consists of:

4 surface escorts which use active sonar.

16 sonobuoys in two flanking fields of eight sonobuoys each. The sonobuoys are narrowband passive processors.

3 Submarine escorts placed forty miles ahead of the CV and fifty miles abreast. Each submarine has a narrowband passive and broadband passive processor.

Three noise indices are used in this example:

1 = Narrowband passive (detected by the sonobuoys and SSNs)

2 = Broadband passive (detected by the SSNs)

5 = Active Target strength (detected by the Surface Escorts).

The sonobuoy and submarine narrowband detection are assumed to be against the same radiated noise level.

Environmental File Definition

The PROP file for the example is defined in the following session. The identity of the indices for the propagation and contour tables is as follows:

Prop Index	Contour Index	Identity
1	1	SSN narrowband sonar
2	2	Sonobuoy narrowband sonar
3	3	SSN broadband sonar
5	5	Surface active sonar

Commentary on the input sequence is given following the input.

```
OK, SEG SCREEN
ENTER ACOUSTIC DATA FILE NO. (1-99): 2
ENTER PROP LOSS CURVE NO. (1- 10): 1
ENTER THE PROP LOSS CURVE LABEL: DDCZ n.b. SSN
AMBIENT NOISE (db) : 69
ENTER RANGE (nm) , PROP LOSS (db)  PAIRS
(ENTER PROP LOSS -200 TO DELETE RANGE ENTRY)
(ENTER 'END' TO POP OUT)
DATA POINT: 1,64
DATA POINT: 5,85
DATA POINT: 7,87
.......  (Data points omitted for brevity)
DATA POINT: END
ENTER ACT. SOURCE LEVEL AND DELT RD FOR REVERB(db)  (0= Exit)
LS (db) AND DELTRD: 0
```

This propagation loss curve is for the narrowband SSN sonar. The symbol 'DDCZ' means: receiver is deep, the source is deep and the curve is for a convergence zone environment. This designation is purely for the convenience of the program user and has no significance to the program operation.

```
ENTER PROP LOSS CURVE NO. (1- 10): 2
ENTER THE PROP LOSS CURVE LABEL: SDCZ n.b. Buoy
AMBIENT NOISE (db) : 54
ENTER RANGE (nm) , PROP LOSS (db)  PAIRS
(ENTER PROP LOSS -200 TO DELETE RANGE ENTRY)
(ENTER 'END' TO POP OUT)
DATA POINT: 1,63
DATA POINT: 4,85
.......  (Data points omitted for brevity)
DATA POINT: END
ENTER ACT. SOURCE LEVEL AND DELT RD FOR REVERB(db)  (0= Exit)
LS (db) AND DELTRD: 0
```

This propagation loss curve is for the narrowband sonobuoys. The symbol 'SDCZ' means: receiver is shallow, the source is deep and the curve is for a convergence zone environment.

```
ENTER PROP LOSS CURVE NO. (1- 10): 3
ENTER THE PROP LOSS CURVE LABEL: DDCZ b.b. SSN
AMBIENT NOISE (db) : 60
ENTER RANGE (nm) , PROP LOSS (db)  PAIRS
(ENTER PROP LOSS -200 TO DELETE RANGE ENTRY)
(ENTER 'END' TO POP OUT)
DATA POINT: 1.,63.
DATA POINT: 2.,70.
.......  (Data points omitted for brevity)
DATA POINT: END
ENTER ACT. SOURCE LEVEL AND DELT RD FOR REVERB(db)  (0= Exit)
LS (db) AND DELTRD: 0
```

This propagation loss curve is for the SSN broadband sonar. The symbol 'DDCZ' has the same meaning as in curve one above.

```
ENTER PROP LOSS CURVE NO. (1- 10): 5
ENTER THE PROP LOSS CURVE LABEL: SDCZ Act. Surf.
AMBIENT NOISE (db) : 60
ENTER RANGE (nm) , PROP LOSS (db)  PAIRS
(ENTER PROP LOSS -200 TO DELETE RANGE ENTRY)
(ENTER 'END' TO POP OUT)
DATA POINT: 1.,63.
DATA POINT: 5.,97.0
DATA POINT: 5.0,95.
DATA POINT: 7.0,101.
DATA POINT: 27.0,115.0
DATA POINT: 30.,92.
DATA POINT: 32.,113.
DATA POINT: 32.0,98.
DATA POINT: END
ENTER ACT. SOURCE LEVEL AND DELT RD FOR REVERB(db)  (0= Exit)
LS (db) AND DELTRD: 230.-20
ENTER REVERB CURVE LABEL: Active Surface
ENTER RANGE (nm) , REVERB (db) PAIRS
ENTER REVERB -200 TO DELETE RANGE ENTRY
ENTER 'END' TO POP OUT
DATA POINT: 1.50
DATA POINT: 3.40
DATA POINT: 5.10
DATA POINT: 10.0
DATA POINT: END
ENTER PROP LOSS CURVE NO. (1- 10): 0
```

This propagation loss curve is for the surface escort active sonar. The symbol 'SDCZ' has the same meaning as in curve two. Since the highest range value entered is 32 miles, the propagation loss curve is truncated at this point. There is no active detection capability beyond 32 miles.

Entering zero (0) propagation loss curve number directs the program to the aspect contour inputs.

```
ENTER ASPECT CONTOUR NO. (1-20): 1
ENTER THE ASPECT CONTOUR LABEL: n.b. Line Array
ENTER DIRECTIVITY INDEX (db) : 10
ENTER BEARING(deg), DELTA SELF-NOISE(db), BW(+-3db) TRIPLES
(ENTER 'END' TO )
(ENTER DELTA SELF-NOISE = -100 TO DELETE ENTRY
DATA POINT: 90,0,6
DATA POINT: 105,0,6,2
DATA POINT: 120,0,6,9
.......  (Data points omitted for brevity)
DATA POINT: END
ENTER REFERENCE BEAMWIDTH (+-3 db DOWN): 6
ENTER SE,SIG.BRG,RELAX.TIME (min): -10,15,30
ENTER SE,SIG.BRG,RELAX.TIME (min): 10,3,15
ENTER SE,SIG.BRG,RELAX.TIME (min): 0,6,15
ENTER SE,SIG.BRG,RELAX.TIME (min): END
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min): END
```

This is the contour definition for the SSN narrowband line array.

```
ENTER ASPECT CONTOUR NO. (1-20): 3
ENTER THE ASPECT CONTOUR LABEL: b.b. Hull Passive
ENTER DIRECTIVITY INDEX (do) : 30
ENTER BEARING(deg), DELTA SELF-NOISE(db), BW(+-3db) TRIPLES
(ENTER 'END' TO POP OUT)
(ENTER DELTA SELF-NOISE = -100 TO DELETE ENTRY
DATA POINT: 0,0,5
DATA POINT: 120,0,5
DATA POINT: 240,0,5
DATA POINT: 150,80,5
DATA POINT: 210,80,5
DATA POINT: END
ENTER REFERENCE BEAMWIDTH (+-3 db DOWN): 5
ENTER SE,SIG.BRG,RELAX.TIME (min): -10,2,30
ENTER SE,SIG.BRG,RELAX.TIME (min): -6,1.5,10
ENTER SE,SIG.BRG,RELAX.TIME (min): 0,1.,7.5
ENTER SE,SIG.BRG,RELAX.TIME (min): 10,.5,3.5
ENTER SE,SIG.BRG,RELAX.TIME (min): END
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min): END
```

This defines the contours for the SSN broadband array. The large 'self noise' between relative bearings 150 and 210 represents the baffles area of the sonar. The baffles are inserted between the array and the ship to shield out ship noise. The effect is to make detections in the baffle region nearly impossible.

```
ENTER ASPECT CONTOUR NO. (1-20): 5
ENTER THE ASPECT CONTOUR LABEL: Act. Surf. Hull
ENTER DIRECTIVITY INDEX (db) : 30
ENTER BEARING(deg), DELTA SELF-NOISE(db), BW(+-3db) TRIPLES
(ENTER 'END' TO POP OUT)
(ENTER DELTA SELF-NOISE = -100 TO DELETE ENTRY
```

```
DATA POINT: 0.0.10
DATA POINT: 120.0.10
DATA POINT: 240.0.10
DATA POINT: 150.80.10
DATA POINT: 210.80.10
DATA POINT: END
ENTER REFERENCE BEAMWIDTH (+-3 db DOWN): 10
ENTER SE,SIG.BRG,RELAX.TIME (min): -10.15.30
ENTER SE,SIG.BRG,RELAX.TIME (min): -5.8.10
ENTER SE,SIG.BRG,RELAX.TIME (min): 0.6.7.5
ENTER SE.SIG.BRG,RELAX.TIME (min): 10.4.3.5
ENTER SE.SIG.BRG,RELAX.TIME (min): END
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min): -10.750.20
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min): 0.250.10
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min): 10.100.3
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min): END
```

This defines the contours for the active sonar. Note that for active sonars the contours for range sigma and lambda have meaning.

```
ENTER ASPECT CONTOUR NO. (1-20): 2
ENTER THE ASPECT CONTOUR LABEL: n.b. Buoy Pass Omni
ENTER DIRECTIVITY INDEX (db) : 0
ENTER BEARING(deg), DELTA SELF-NOISE(db), BW(+-3db) TRIPLES
(ENTER 'END' TO )
(ENTER DELTA SELF-NOISE = -100 TO DELETE ENTRY
DATA POINT: END
ENTER REFERENCE BEAMWIDTH (+-3 db DOWN): 0
ENTER SE,SIG.BRG,RELAX.TIME (min): END
ENTER SE, SIG.RANGE (yds), RELAX.TIME (min): END
ENTER ASPECT CONTOUR NO. (1-20): 0
```

The last contour definition is for the passive sonobuoys which are omnidirectional. Since the default contour values lead to an omni sensor which is ambient noise limited, it is unnecessary to enter any values except directivity index, which is of course zero.

By exercising option LLOS and LCON, it is possible to display the contents of the PROP file defined above. The output is shown in the following figures.

FIGURE V-1
PROPAGATION LOSS CURVE NO. 1   DDCZ n.b. SSN

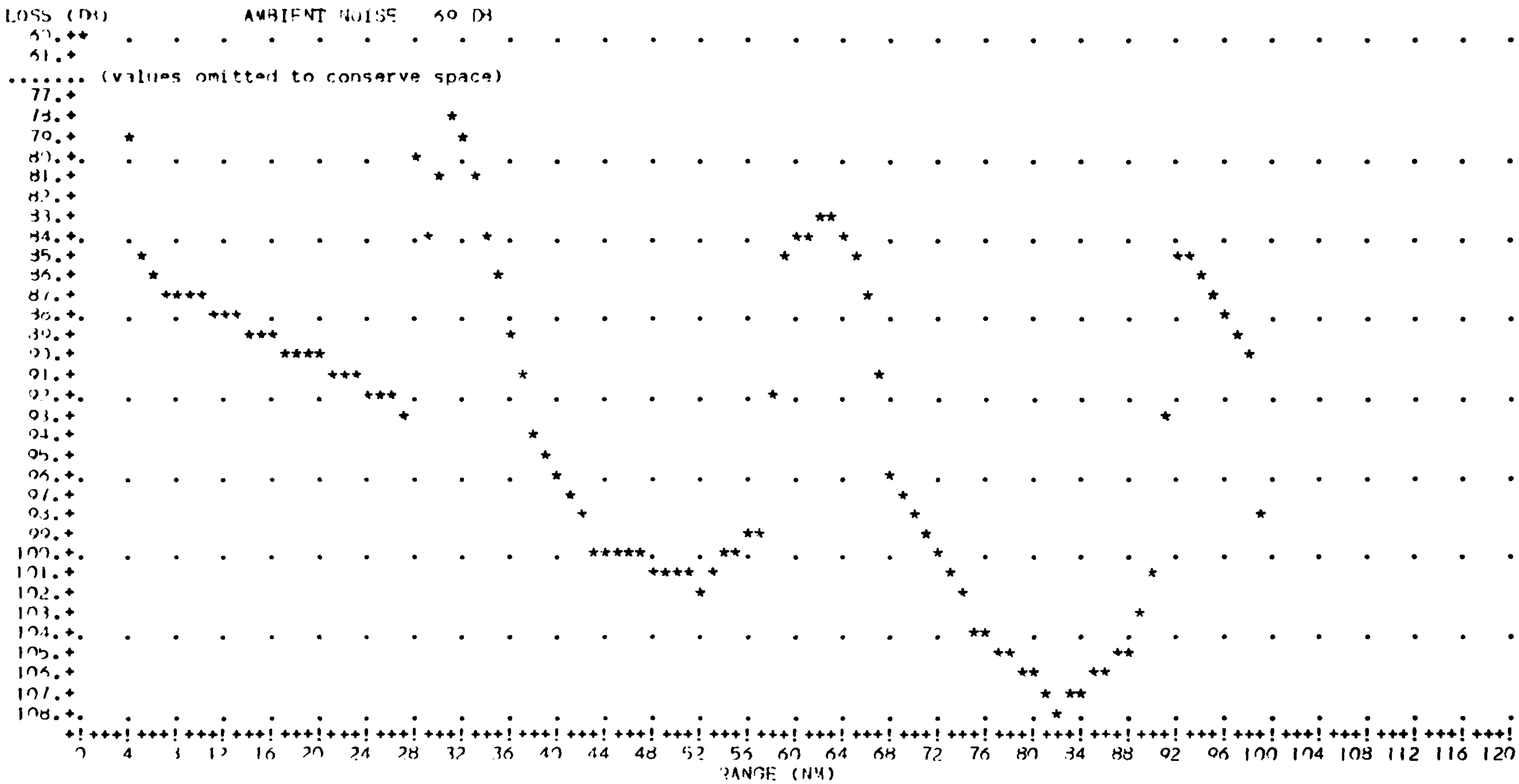


FIGURE V-2
PROPAGATION LOSS CURVE NO. 2 SDCZ n.b. Buoy

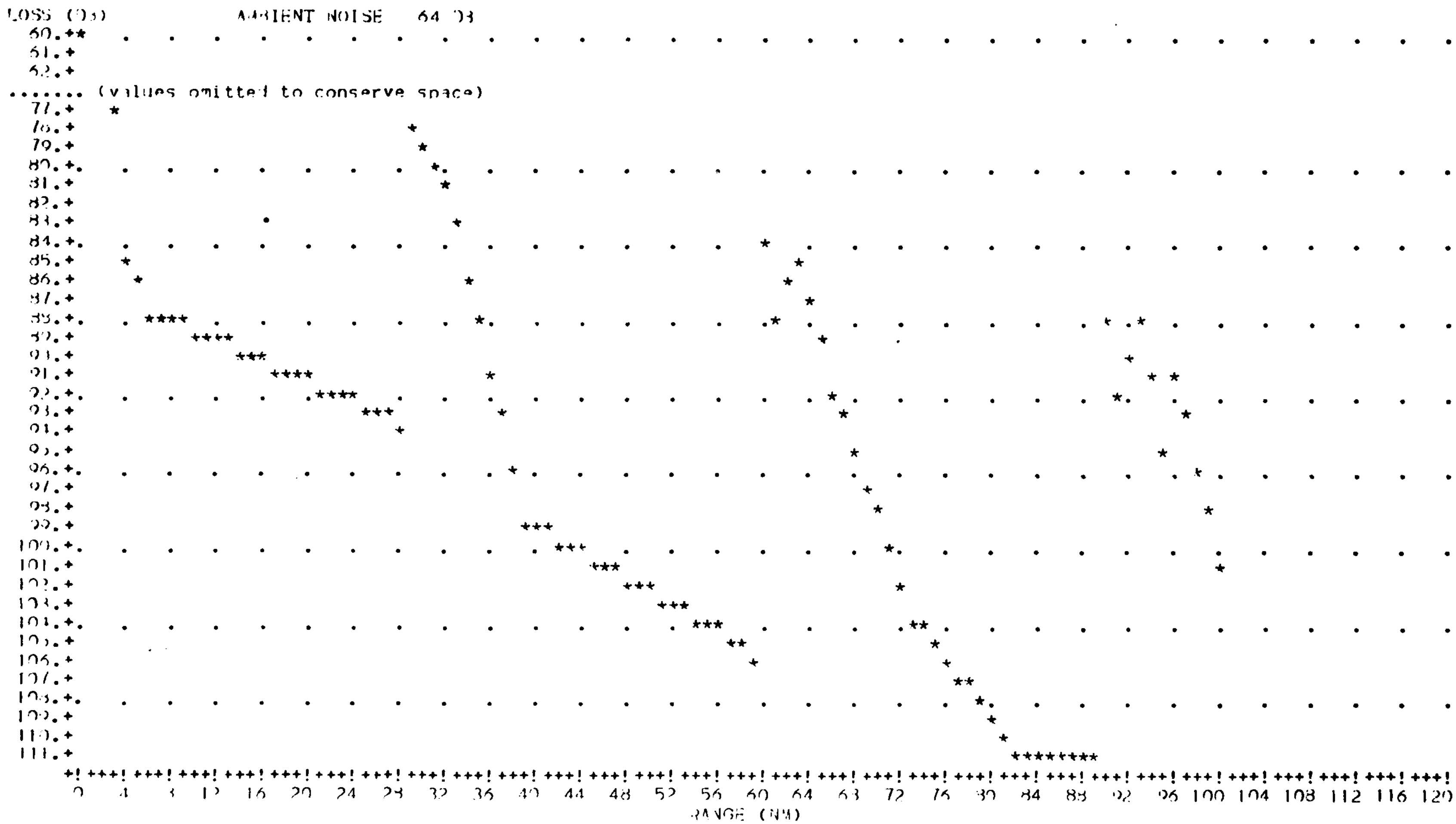


FIGURE V-3
PROPAGATION LOSS CURVE NO. 3   DDCZ b.b. SSN

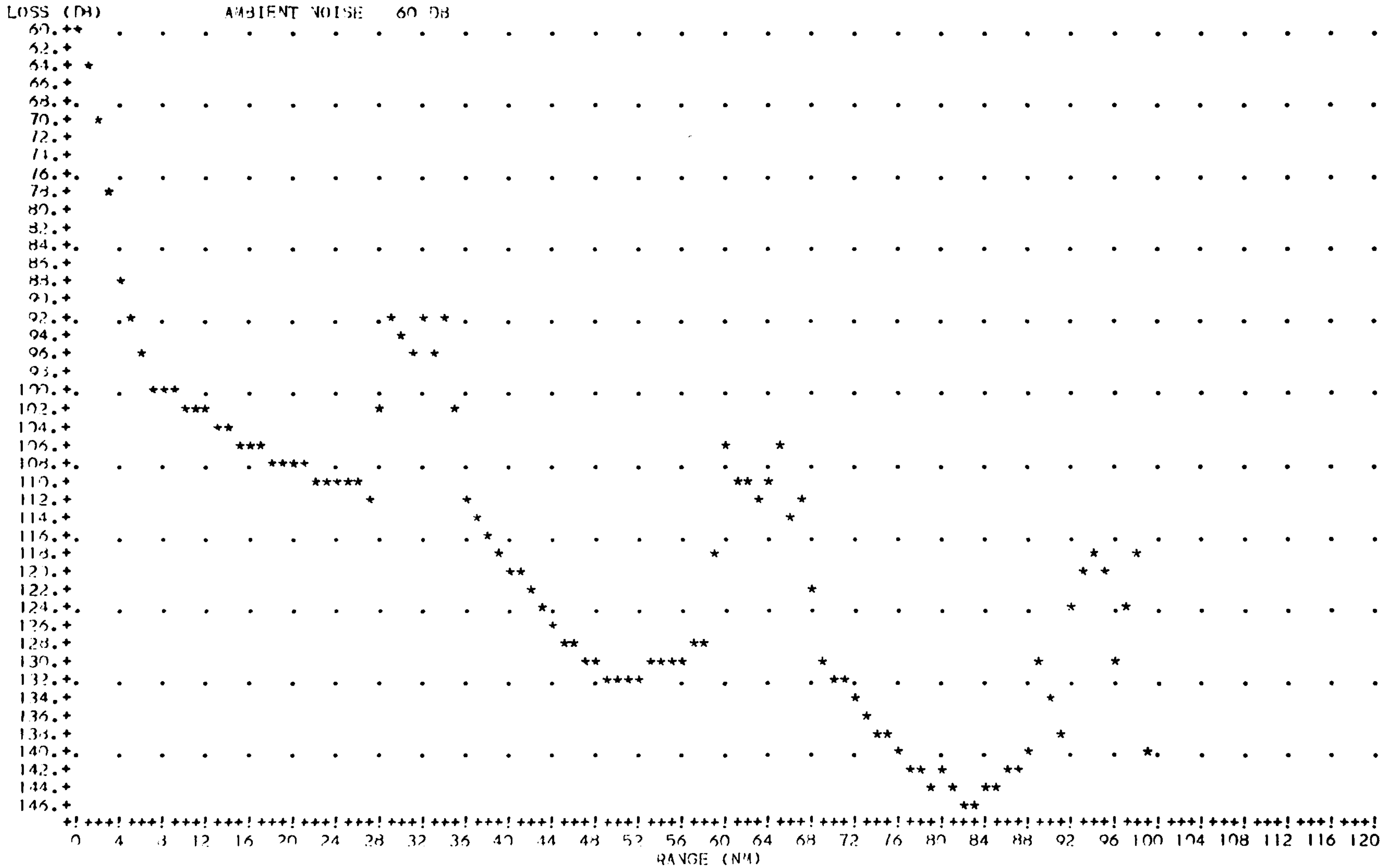


FIGURE V-4

PROPAGATION LOSS CURVE NO. 5   SDCZ Act. Surf.

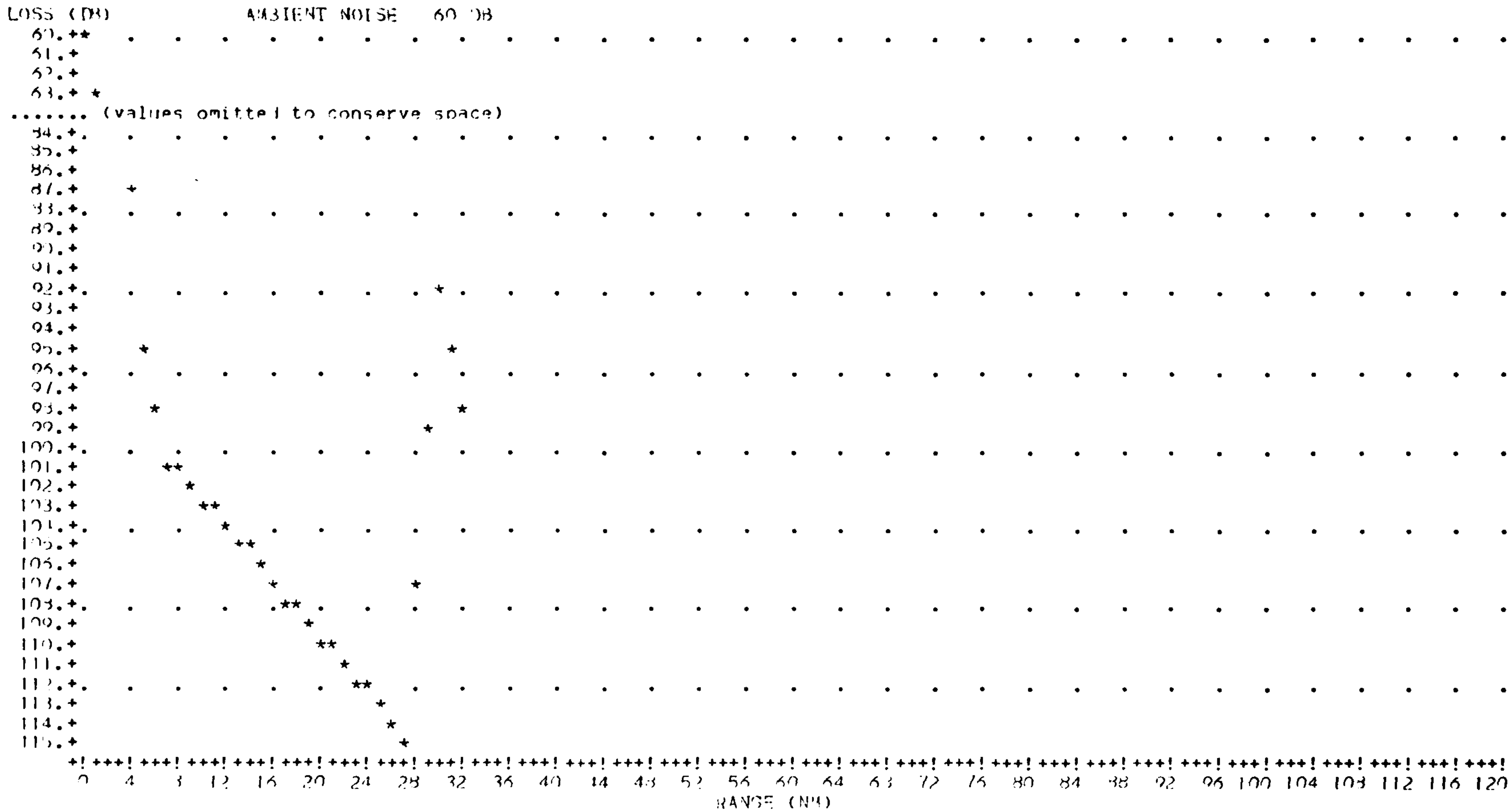
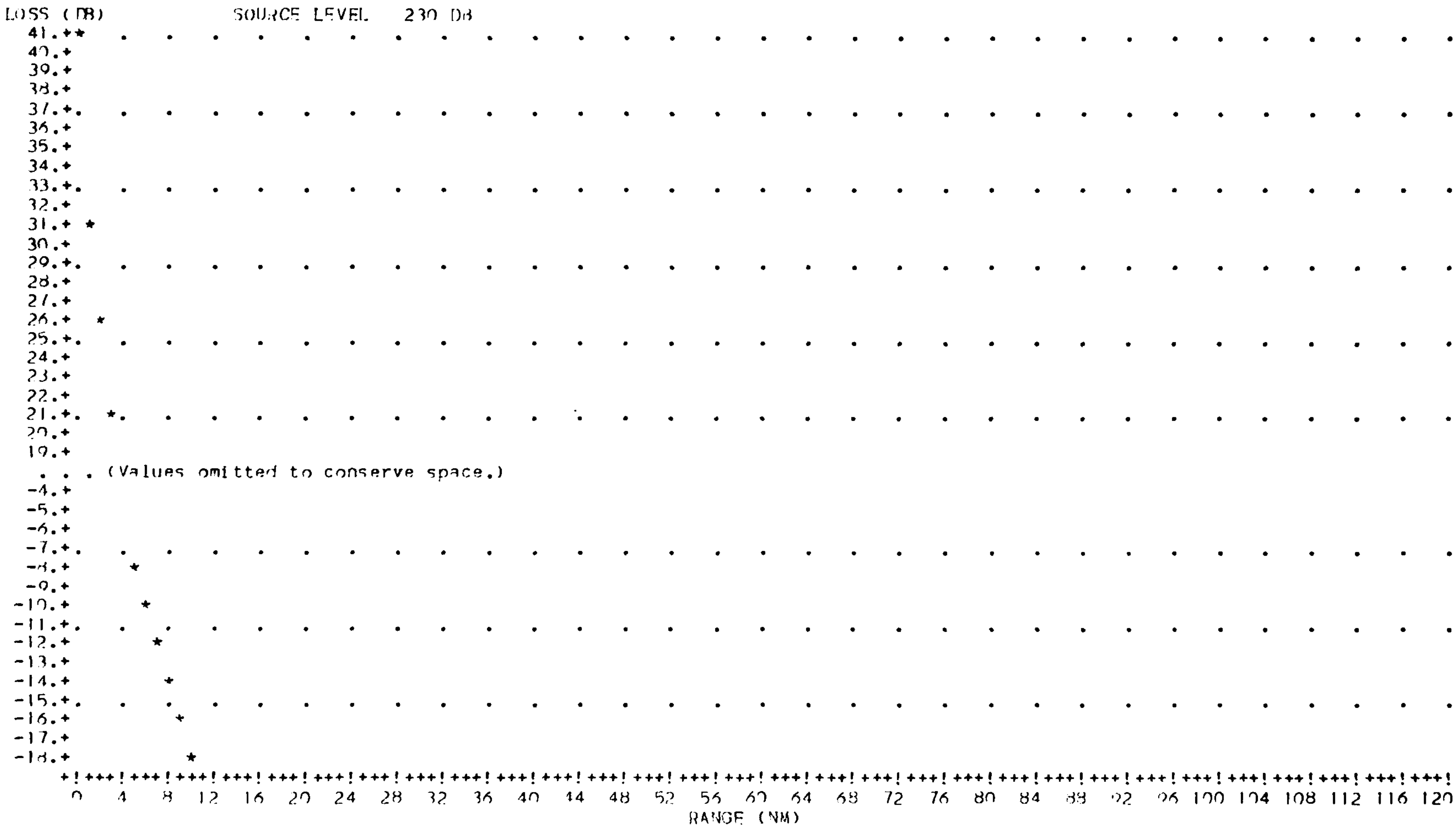


FIGURE V-5
REVERBERATION CURVE NO. 15 Active Surface



Note that the plotted value in the reverberation curve, Figure V-5, is the algebraic sum of the input reverberation and the delta recognition differential for the reverberation limited case.

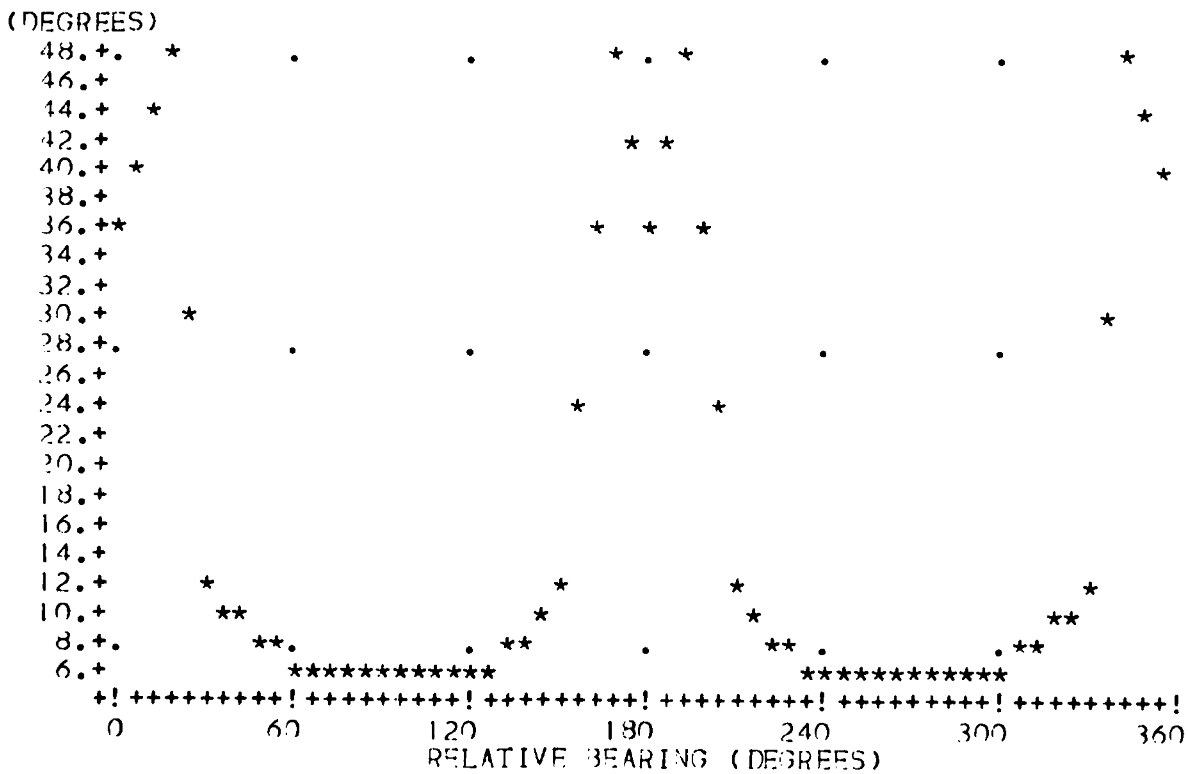
FIGURE V-6

```
                                   ASPECT CONTOUR NO.  1     n.b. Line Array
                              DIRECTIVITY INDEX=     10
 DELTA LN-NDI (DB)
   2.0+*****      .        .        .        .        .     ***
   1.9+
   1.8+
   1.7+
   1.6+
   1.5+
   1.4+
   1.3+
   1.2+
   1.1+
   1.0+.   *      .        .        .        .        .    *
   0.9+
   0.8+
   0.7+
   0.6+
   0.5+
   0.4+
   0.3+
   0.2+
   0.1+
   0.0+.    **********************************************
      +!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!
       0        60        120       180       240       300       360
                              RELATIVE BEARING (DEGREES)
```

This contour indicates slightly more self-noise in the direction of the towing submarine.

FIGURE V-7

BEAMWIDTH



This beamwidth contour for the line array has the smallest beams perpendicular to the array and larger ones on the ends.

FIGURE V-8

SIGMA BEARING NO. 1
REFERENCE BEAMWIDTH 6

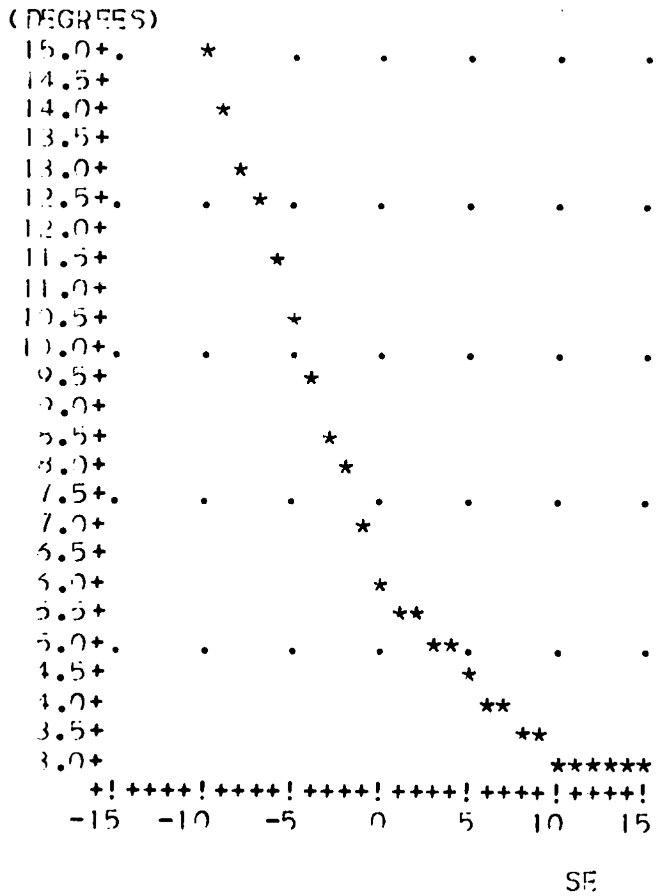


FIGURE V-9

LAMBDA BEARING NO. 1

```
(MINUTES)
 30.0+.    *    .    .    .    .    .
 29.5+
 29.0+
 28.5+      *
 28.0+
 27.5+.    .    .    .    .    .    .
 27.0+       *
 26.5+
 26.0+
 25.5+        *
 25.0+.    .    .    .    .    .    .
 24.5+
 24.0+         *
 23.5+
 23.0+
 22.5+.    .    *    .    .    .    .
 22.0+
 21.5+
 21.0+           *
 20.5+
 20.0+.    .    .    .    .    .    .
 19.5+            *
 19.0+
 18.5+
 18.0+             *
 17.5+.    .    .    .    .    .    .
 17.0+
 16.5+              *
 16.0+
 15.5+
 15.0+.    .    .    ****************
     +!++++!++++!++++!++++!++++!++++!
    -15  -10   -5    0    5   10   15
```

SE

FIGURE V-10

```
                                 ASPECT CONTOUR NO.  3    b.b. Hull Passive
                              DIRECTIVITY INDEX=    30
DELTA LN-NDI (DB)
   80.+.         .         .    ***********    .         .
   75.+
   70.+
   65.+                        *           *
   60.+
   55.+
   50.+                       *             *
   45.+
   40.+
   35.+
   30.+.         .         . *       .       * .         .
   25.+
   20.+
   15.+                      *                 *
   10.+
    5.+
    0.**********************                   ********************
      +!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!
       0         60        120       180       240       300       360
                           RELATIVE BEARING (DEGREES)
```

This self-noise contour models the baffle area on the hull array by greatly increasing the self-noise in that region.

FIGURE V-11

```
                              BEAMWIDTH

(DEGREES)
    5.*************************************************************
      +!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!
       0         60        120       180       240       300       360
                           RELATIVE BEARING (DEGREES)
```

The beamwidth is constant for the hull array.

FIGURE V-12

SIGMA BEARING NO. 3
REFERENCE BEAMWIDTH 5

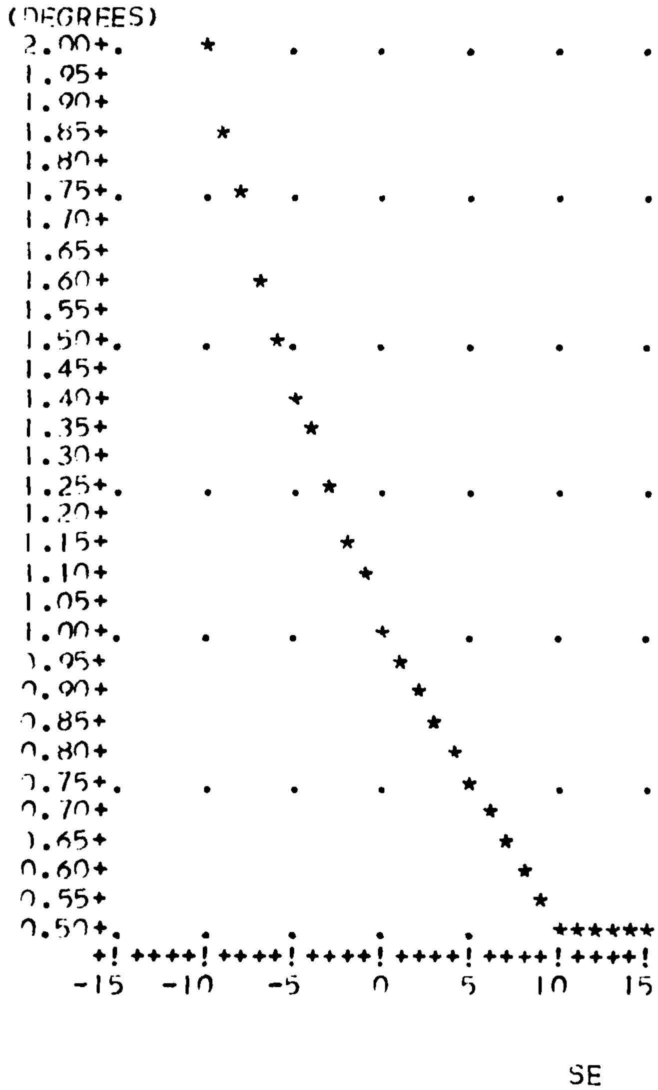


FIGURE V-13

LAMBDA BEARING NO. 3

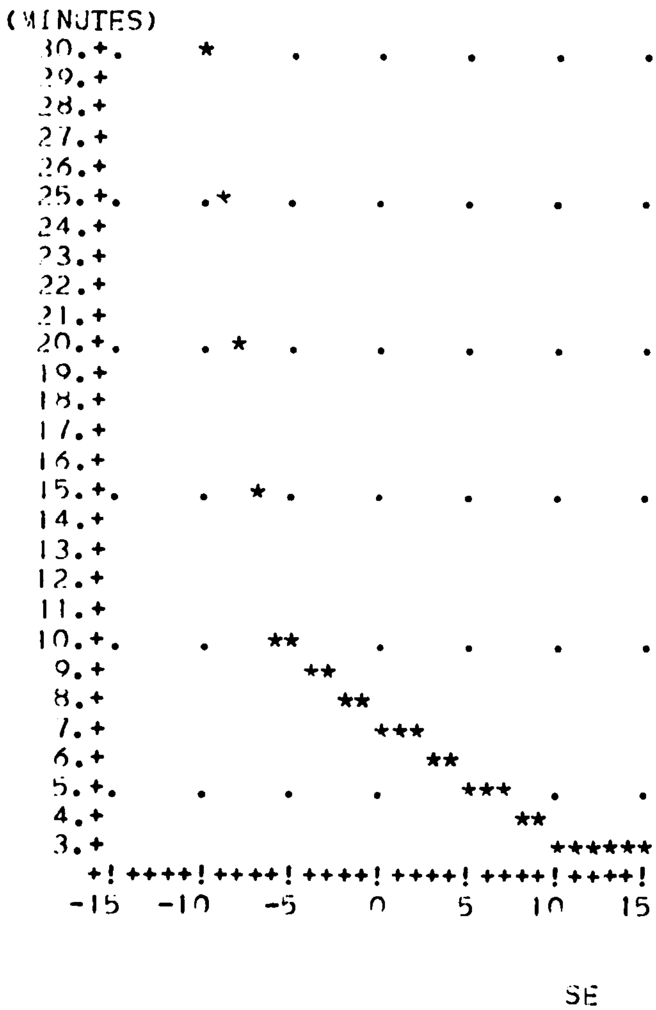


FIGURE V-14

```
                        ASPECT CONTOUR NO.  5    Act. Surf. Hull
                     DIRECTIVITY INDEX=     30
DELTA LN-NDI (DB)
80.+.         .         .    ***********    .         .
75.+
70.+
65.+                        *           *
60.+
55.+
50.+                       *             *
45.+
40.+
35.+
30.+.         .         . *       .       * .         .
25.+
20.+
15.+                     *                 *
10.+
 5.+
 0.+*********************                   ********************
   +!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!
    0        60       120       180       240       300       360
                      RELATIVE BEARING (DEGREES)
```

FIGURE V-15

BEAMWIDTH

```
(DEGREES)
10.+************************************************************
   +!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!+++++++++!
    0        60       120       180       240       300       360
                      RELATIVE BEARING (DEGREES)
```

FIGURE V-16

SIGMA BEARING NO.   5
REFERENCE BEAMWIDTH   10

```
(DEGREES)
15.0+.    *    .    .    .    .    .
14.5+
14.0+
13.5+      *
13.0+
12.5+.    .    .    .    .    .    .
12.0+       *
11.5+
11.0+        *
10.5+
10.0+.    .    .    .    .    .    .
 9.5+         *
 9.0+
 8.5+
 8.0+          *
 7.5+.    .    .*   .    .    .    .
 7.0+            **
 6.5+              *
 6.0+               **
 5.5+                 **
 5.0+.    .    .    .   ***  .    .
 4.5+                      **
 4.0+                        *******
    +!++++!++++!++++!++++!++++!++++!
   -15  -10   -5    0    5   10   15
```

SE

FIGURE V-17

LAMBDA BEARING NO. 5

```
(MINUTES)
30.+.    *    .    .    .    .    .
29.+
28.+
27.+
26.+      *
25.+.    .    .    .    .    .    .
24.+
23.+
22.+       *
21.+
20.+.    .    .    .    .    .    .
19.+
18.+        *
17.+
16.+
15.+.    .    .    .    .    .    .
14.+         *
13.+
12.+
11.+
10.+.    .    *    .    .    .    .
 9.+           **
 8.+             **
 7.+               ***
 6.+                  **
 5.+.    .    .         ***  .    .
 4.+                       **
 3.+                         ******
   +!++++!++++!++++!++++!++++!++++!
   -15  -10  -5    0    5   10   15
```

SE

FIGURE V-18

SIGMA RANGE NO. 5

```
(YARDS)
 750.+.    *    .    .    .    .    .
 700.+      *
 650.+       *
 600.+        *
 550.+         *
 500.+.    .    *    .    .    .    .
 450.+           *
 400.+            *
 350.+             *
 300.+              *
 250.+.    .    .    **   .    .    .
 200.+                 ***
 150.+                    ****
 100.+                        *******
     +!++++!++++!++++!++++!++++!++++!
    -15  -10   -5    0    5   10   15
                                 SE
```

The active sensor has sigma range and lambda range contours.

FIGURE V-19

LAMBDA RANGE NO. 5

```
(MINUTES)
  20.+.    *    .    .    .    .    .
  19.+      *
  18.+       *
  17.+        *
  16.+         *
  15.+.    .    *    .    .    .    .
  14.+           *
  13.+            *
  12.+             *
  11.+              *
  10.+.    .    .    *    .    .    .
   9.+                **
   8.+                  *
   7.+                   *
   6.+                    **
   5.+.    .    .    .    . *  .    .
   4.+                       **
   3.+                         ******
     +!++++!++++!++++!++++!++++!++++!
    -15  -10   -5    0    5   10   15
                                 SE
```

Initial Sensor File Definition

The following sequence of operations define the sensor screen. Commentary on the input sequence is given following each block of input.

```
OK. SEG SCREEN
 ENTER ACOUSTIC DATA FILE NO. (1-99): 0
 ENTER SENSOR FILE NUMBER (1-99): 1
 ENTER SENSOR FILE NAME:A TYPICAL SENSOR SCREEN
 ENTER START DTG (DD,HH,MM): 0,0,0
 ENTER DELTA T (hrs) :.25
 ENTER INITIAL PIM COORD (X,Y) (nm): 0,0
 ENTER INITIAL PIM SPEED (kts),HEADING (deg): 20,0
```

Note that no acoustic file is needed to set up the screen formation. The values of DELTA T and PIM are chosen for convenience. Generally, DELTA T will be selected to step the problem in small enough time intervals to provide sufficient flexibility in describing the sensor and target tactics, e.g., course and speed changes, sprint drift cycles, sonobuoy replacement, etc. There is no need to be concerned about time steps that are too large and permit a target to 'jump' over a CZ. The relative target sensor motions during detection and localization evaluation are subdivided so that no point on a propagation loss curve is skipped over. As noted, PIM speed is 20 knots.

```
 ENTER THE HVU NO. (1-  5): 1
 ENTER THE HVU LABEL (ENTER $$ TO DELETE): CARRIER (CV)
 ENTER HVU INITIAL COORDINATES (nm): 0,0
 ENTER HVU SOURCE INDEX AND LEVEL (db)(0=Exit): 1,165
 ENTER HVU SOURCE INDEX AND LEVEL (db)(0=Exit): 2,120
 ENTER HVU SOURCE INDEX AND LEVEL (db)(0=Exit): 0
 ENTER THE HVU NO. (1-  5): 0
```

The HVU is arbitrarily set at the PIM position. The carrier provides noise interference at each of the two passive noise indices, but not at the active index.

```
 DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): Y
 ENTER SENSOR LABEL, ($$=DELETE): Surf. Act. Escort
 ENTER TYPE OF SENSOR (P, A, L, O): A
 ENTER INITIAL COORDINATES (X,Y) (nm): 5,5
 ENTER SPEED (kts) AND HEADING (deg): 20,0
 ENTER NOISE SD  AND MEAN SELF-NOISE LEVEL (db): 10,25
 ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 1,150
 ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 2,115
 ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 0
 ENTER PL NO., ASPECT NO.,TGT NOISE NO.: 5,5,5
 ENTER LAMBDA (#/hr) AND SIGMA (db): 2,6
 ENTER SCAN TIME AND INTEGRATION TIME (min): 10,3
 ENTER PROBABILITY SENSOR IS AVAILABLE(RANGE 0-1): .8
```

The active PL,etc. are all index 5 (purely for convenience).

```
MORE SENSORS IN SUBGROUP OF GROUP (Y OR N): N
ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): N
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: 5,-5
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -5,5
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -5,-5
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): N
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): N
ENTER TARGET FILE NO. (1- 99): 0
ENTER FILENAME FOR OUTPUT (C for console): C
```

The first sensor has been copied in each of the remaining three surface escort locations. After defining the surface escorts the user decided to exit without loading a target file. Recall that a SENS file can be established either in INIT or in USEN (at time step 0). In this example, the rest of the file will be established in USEN. In the last statement the user has specified that all output would appear on the user terminal.

```
SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 1

PICK KEY 0 TO 4, 0=EXIT  1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 4
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): Y
ENTER SENSOR LABEL, ($$=DELETE): Omni Sonobuoy
ENTER TYPE OF SENSOR (P, A, L, O): P
ENTER INITIAL COORDINATES (X,Y) (nm): -20,20
ENTER SPEED (kts) AND HEADING (deg): 0,0
ENTER NOISE RD  AND MEAN SELF-NOISE LEVEL (db): 5,0
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 0
ENTER PL NO., ASPECT NO.,TGT NOISE NO.: 2,2,1
ENTER LAMBDA (#/hr) AND SIGMA (db): 1,9
ENTER SCAN TIME AND INTEGRATION TIME (min): 1,5
ENTER PROBABILITY SENSOR IS AVAILABLE(0-1): .75
```

This defines the 'kingpin' sonobuoy of the left (port) flanking sonobuoy field. The sonobuoy is stationary in the water and effectively radiates no noise. Noise index one (1) is assigned to the narrowband frequency which the sonobuoy detects.

```
MORE SENSORS IN SUBGROUP OF GROUP (Y OR N): N
```

The vertical row of four buoys is defined as a group for purposes

of constructing the fields. This group definition will be changed below.

```
ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): Y
ENTER GROUP CORRELATION (RANGE 0-1): .5
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -20,15
ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -20,10
ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -20,5
ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): N

MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -17.5,17.5
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: 17.5,17.5
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: 20,20
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): N
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): N

PICK KEY 0 TO 4, 0=EXIT  1=NAME   TIME
   2=PIM  3=HVJ  4=SEN
ENTER KEY: 0
```

The vertical rows of buoys are copied in all of the row positions using the coordinates of the kingpin to locate the groups. The result of this may be shown in a call to LSEN if desired.

```
ENTER KEY (14 GIVES LIST): 11
ENTER SENS NO., GROUP NO.: 9,5
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
ENTER SENS NO., GROUP NO.: 10,5
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
ENTER SENS NO., GROUP NO.: 11,5
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
ENTER SENS NO., GROUP NO.: 12,5
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
ENTER SENS NO., GROUP NO.: 17,13
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
ENTER SENS NO., GROUP NO.: 18,13
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
ENTER SENS NO., GROUP NO.: 19,13
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
ENTER SENS NO., GROUP NO.: 20,13
ENTER GROUP CORRELATION (NEG IS NO CHANGE): -1
```

ENTER SENS NO., GROUP NO.: 0

This session is used to redefine the sonobuoy groupings. Each flanking field is considered to be a group. The sensor number of the kingpin is (arbitrarily) selected as the group number. Any number is acceptable as a group identification -- the only requirement is that all group members must have the same identification The negative input for group correlation means that the existing value is unchanged.

Next, the submarine escort sensors are defined.

```
ENTER KEY (14 GIVES LIST): 1

PICK KEY 0 TO 4, 0=EXIT  1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 4
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): Y
ENTER SENSOR LABEL, ($$=DELETE): SSN Narrowband
ENTER TYPE OF SENSOR (P, A, L, O): L
ENTER INITIAL COORDINATES (X,Y) (nm): 0,50
ENTER SPEED (kts) AND HEADING (deg): 10,0
ENTER NOISE RD  AND MEAN SELF-NOISE LEVEL (db): 15,30
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 1,130
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 2,105
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 0
ENTER PL NO., ASPECT NO.,TGT NOISE NO.: 1,1,1
ENTER LAMBDA (#/hr) AND SIGMA (db): 1,5
ENTER SCAN TIME AND INTEGRATION TIME (min): 5,5
ENTER PROBABILITY SENSOR IS AVAILABLE(0-1): .95
MORE SENSORS IN SUBGROUP OF GROUP (Y OR N): Y
ENTER GROUP CORRELATION (RANGE 0-1): .25

ENTER SENSOR LABEL, ($$=DELETE): SSN Broadband
ENTER TYPE OF SENSOR (P, A, L, O): P
ENTER INITIAL COORDINATES (X,Y) (nm): 0,50
ENTER SPEED (kts) AND HEADING (deg): 10,0
ENTER NOISE RD  AND MEAN SELF-NOISE LEVEL (db): -10,10
ENTER SEN SOURCE INDEX AND LEVEL (db)(0=Exit): 0
ENTER PL NO., ASPECT NO.,TGT NOISE NO.: 3,3,2
ENTER LAMBDA (#/hr) AND SIGMA (db): 1,5
ENTER SCAN TIME AND INTEGRATION TIME (min): 1,'
ENTER PROBABILITY SENSOR IS AVAILABLE(0-1): .9
MORE SENSORS IN SUBGROUP OF GROUP (Y OR N): N
ANOTHER COPY OF SUBGROUP IN GROUP (Y OR N): N
```

These two sensors define the SSN escort sensors. The narrowband sensor is a line array, which detects the same frequency as the sonobuoys. The broadband sensor is hull mounted and operates against noise index two. The broadband sensor has the same location as the narrowband sensor since it is on the same platform. No noise is defined for the broadband sensor since the platform's radiated noise should be defined only once for each platform (otherwise the program

will treat each sensor on the platform as an independent noise source). The two sensors are slightly correlated (.25).

```
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: -50,40
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): Y
ENTER INITIAL X,Y COORDINATES (nm) FOR FIRST SENSOR
COORDINATE PAIR: 50,40
MAKE ANOTHER COPY OF THIS GROUP (Y OR N): N
DO YOU WANT TO DEFINE MORE SENSORS (Y OR N): N

PICK KEY 0 TO 4, 0=EXIT   1=NAME   TIME
   2=PIM  3=HVU  4=SEN
ENTER KEY: 0
ENTER KEY (14 GIVES LIST): 0
```

The remaining SSNs are copies of the center SSN. Note that all SSNs are moving at 10 knots. This means that they will lag PIM, and require a sprint to catch up at some point in time. The slow speed is necessary to obtain good search coverage.

At this point we will list the sensors with a call to LSEN to see what has been accomplished thus far.

```
*****************************

SELECT MODE (HELP GIVES LIST): LSEN
```

FIGURE V-20

A TYPICAL SENSOR SCREEN

CONFIGURATION 0

SENSOR PARAMETERS AT TIME STEP 0 HOUR 00.00.00

	SENS/GRP		TYPE		COORDINATES n.m.	n.m.	SPEED kts	HEADING deg	RD db	LE db	LE CONTOUR	PROP LOSS	LAM #/hr	SIG db	NOIS INDX	CORR	RATE min	TIMINT min	AVAIL
1	1	Surf. Act. Escort	A		5.0	5.0	20.0	0.0	10	25	5	5	2.0	6.0	5	0.00	10.00	3.00	0.80
2	2	Surf. Act. Escort	A		5.0	-5.0	20.0	0.0	10	25	5	5	2.0	6.0	5	0.00	10.00	3.00	0.80
3	3	Surf. Act. Escort	A		-5.0	5.0	20.0	0.0	10	25	5	5	2.0	6.0	5	0.00	10.00	3.00	0.80
4	4	Surf. Act. Escort	A		-5.0	-5.0	20.0	0.0	10	25	5	5	2.0	6.0	5	0.00	10.00	3.00	0.80
5	5	Omni Sonobuoy	P		-20.0	20.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
6	5	Omni Sonobuoy	P		-20.0	15.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
7	5	Omni Sonobuoy	P		-20.0	10.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
8	5	Omni Sonobuoy	P		-20.0	5.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
9	5	Omni Sonobuoy	P		-17.5	17.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
10	5	Omni Sonobuoy	P		-17.5	12.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
11	5	Omni Sonobuoy	P		-17.5	7.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
12	5	Omni Sonobuoy	P		-17.5	2.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
13	13	Omni Sonobuoy	P		17.5	17.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
14	13	Omni Sonobuoy	P		17.5	12.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
15	13	Omni Sonobuoy	P		17.5	7.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
16	13	Omni Sonobuoy	P		17.5	2.5	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
17	13	Omni Sonobuoy	P		20.0	20.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
18	13	Omni Sonobuoy	P		20.0	15.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
19	13	Omni Sonobuoy	P		20.0	10.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
20	13	Omni Sonobuoy	P		20.0	5.0	0.0	0.0	5	0	2	2	1.0	9.0	1	0.50	1.00	5.00	0.75
21	21	SSN Narrowband	P	LA	0.0	50.0	10.0	0.0	15	30	1	1	1.0	5.0	1	0.25	5.00	5.00	0.95
22	21	SSN Broadband	P		0.0	50.0	10.0	0.0	-10	10	3	3	1.0	5.0	2	0.25	1.00	1.00	0.90
23	23	SSN Narrowband	P	LA	-50.0	40.0	10.0	0.0	15	30	1	1	1.0	5.0	1	0.25	5.00	5.00	0.95
24	23	SSN Broadband	P		-50.0	40.0	10.0	0.0	-10	10	3	3	1.0	5.0	2	0.25	1.00	1.00	0.90
25	25	SSN Narrowband	P	LA	50.0	40.0	10.0	0.0	15	30	1	1	1.0	5.0	1	0.25	5.00	5.00	0.95
26	25	SSN Broadband	P		50.0	40.0	10.0	0.0	-10	10	3	3	1.0	5.0	2	0.25	1.00	1.00	0.90

The LE contour name and PL name are missing because no PROP file was declared.

FIGURE V-20 (continued)

SENSOR PLATFORM SOURCE LEVELS	1	2	3	4	5	6	7	8	9	10
1 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
2 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
3 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
4 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
5 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
6 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
7 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
8 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
9 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
10 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
11 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
12 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
13 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
14 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
15 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
16 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
17 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
18 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
19 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
20 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
21 SSN Narrowband	130	105	-999	-999	-999	-999	-999	-999	-999	-999
22 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
23 SSN Narrowband	130	105	-999	-999	-999	-999	-999	-999	-999	-999
24 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
25 SSN Narrowband	130	105	-999	-999	-999	-999	-999	-999	-999	-999
26 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999

****

Building the SENSOR File in Time

At this point the sensor screen is defined at time step zero. The screen definition will have to be updated as time passes, or else the configuration will not make sense. The sonobuoy fields are stationary, and must be replaced periodically, and the SSNs cannot maintain the 10 knot search speed, or else they will be overrun by the main body of the screen. Thus we must timestep the screen and update the configuration. We will now indicate how this is done. Since the steps are highly repetitive, only the outline of the procedure is given.

Screen configurations. The SSNs must retain their average positions relative to PIM. This is achieved by a sprint-and-drift tactic. For this example, the tactic consists in making 10 knots and 30 knots on alternate legs, which averages out to the PIM speed of 20 knots. The center SSN and the flanking SSNs will be on alternate cycles. When the SSNs are sprinting, they are 'blind', i.e. the sensors are turned off.

The sonobuoys are assumed to remain active for 1.5 hours (6 time steps) ; relaying of the field takes half an hour (2 time steps). The port and starboard fields will be laid alternately.

These considerations lead to six distinct screen configurations, as shown in the following table.

Screen Configurations

Configuraton	Flanking SSNs	Center SSN	Port Buoys	Stbd Buoys
10	Sprint	Search	Search	Search
20	Search	Sprint	Search	Search
11	Sprint	Search	Relay	Search
21	Search	Sprint	Relay	Search
10	Sprint	Search	Search	Search
20	Search	Sprint	Search	Search
12	Sprint	Search	Search	Relay
22	Search	Sprint	Search	Relay

The screen alternates through these configurations in sequence, starting with configuration 10 at timestep zero. The configuration numbers are arbitrary.

The SCREEN program creates a sensor file with these alternating configurations by timestepping one step at a time and using USEN to re-configure the screen at each step. The procedure is repetitive, but easily done by use of the COMI option with existing command files for each of the configurations. We will show the first three timesteps to illustrate the procedure.

```
******************************

SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 5,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 6,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 7,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 8,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 9,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 10,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 11,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 12,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 13,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 14,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 15,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 16,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 17,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 18,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 19,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 20,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0

ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -  0): 0,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 5,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 6,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 7,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 8,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 9,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 10,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 11,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 12,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 13,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 14,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 15,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 16,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 17,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 18,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 19,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 20,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 0
ENTER KEY (14 GIVES LIST): 0
```

This sets up the buoys for time steps zero, eight and sixteen.

```
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 21,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 22,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 23,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 24,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 25,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 26,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -   0): 0,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 21,L
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 22,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 23,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 24,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 25,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 26,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 0
ENTER KEY (14 GIVES LIST): 12
ENTER START,STOP STEPS (0 -   0): 0,0
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,1,130
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,2,105
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 0
ENTER KEY (14 GIVES LIST): 0
```

This block of code makes the center SSN search and the flanking SSNs sprint. Three declarations are needed to do this: (1) set the SSN speed, (2) turn the sensors on or off, and (3) change the noise levels. Remember that the noise levels are only changed on the line array sensor since two sensors are on the same platform.

For timesteps one, etc. the following operations are performed.

```
******************************

SELECT MODE (HELP GIVES LIST): TSTEP
ENTER NEW PROGRAM TIME STEP: 1

******************************

SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 21,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 22,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 23,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 24,10,0
```

```
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 25,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 26,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -  1): 1,1
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 21,O
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 22,O
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 23,L
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 24,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 25,L
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 26,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR O): 0
ENTER KEY (14 GIVES LIST): 12
ENTER START,STOP STEPS (0 -  1): 1,1
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,1,130
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,2,105
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,1,130
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,2,105
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 0
ENTER KEY (14 GIVES LIST): 0


*******************************


SELECT MODE (HELP GIVES LIST): TSTEP
ENTER NEW PROGRAM TIME STEP: 2


*******************************


SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 5,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 6,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 7,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 8,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 9,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 10,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 11,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 12,80,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 13,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 14,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 15,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 16,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 17,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 18,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 19,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 20,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
```

```
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -  2): 2,2
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 5,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 6,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 7,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 8,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 9,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 10,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 11,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 12,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 13,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 14,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 15,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 16,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 17,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 18,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 19,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 20,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 0
ENTER KEY (14 GIVES LIST): 0


******************************


SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 21,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 22,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 23,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 24,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 25,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 26,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -  2): 2,2
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 21,L
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 22,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 23,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 24,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 25,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 26,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 0
ENTER KEY (14 GIVES LIST): 12
ENTER START,STOP STEPS (0 -  2): 2,2
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,1,130
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,2,105
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 0
ENTER KEY (14 GIVES LIST): 0
```

```
******************************

SELECT MODE (HELP GIVES LIST): ISTEP
ENTER NEW PROGRAM TIME STEP: 3

******************************

SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 21,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 22,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 23,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 24,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 25,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 26,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -  3): 3,3
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 21,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 22,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 23,L
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 24,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 25,L
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 26,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 0
ENTER KEY (14 GIVES LIST): 12
ENTER START,STOP STEPS (0 -  3): 3,3
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,1,130
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,2,105
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,1,130
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,2,105
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 0
ENTER KEY (14 GIVES LIST): 0
```

```
******************************

SELECT MODE (HELP GIVES LIST): TSTEP
ENTER NEW PROGRAM TIME STEP: 4

******************************

SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 5,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 6,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 7,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 8,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 9,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 10,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 11,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 12,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 13,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 14,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 15,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 16,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 17,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 18,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 19,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 20,0,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -  4): 4,4
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 5,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 6,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 7,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 8,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 9,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 10,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 11,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 12,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 13,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 14,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 15,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 16,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 17,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 18,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 19,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 20,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 0
ENTER KEY (14 GIVES LIST): 0

******************************
```

```
SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 5
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 21,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 22,10,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 23,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 24,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 25,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 26,30,0
ENTER SENSOR NO.,SPEED (kts), AND HEADING (deg): 0
ENTER KEY (14 GIVES LIST): 3
ENTER START,STOP STEPS (0 -  4): 4,4
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 21,L
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 22,P
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 23,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 24,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 25,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 26,0
ENTER SENSOR NO., SENSOR TYPE (P,A,LA OR 0): 0
ENTER KEY (14 GIVES LIST): 12
ENTER START,STOP STEPS (0 -  4): 4,4
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,1,130
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 21,2,105
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 23,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,1,145
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 25,2,120
ENTER SENSOR NO.,INDEX,SOURCE LEVEL (db) (0 TO EXIT): 0
ENTER KEY (14 GIVES LIST): 0
```

****

Similar operations are performed for each timestep, up to step 21. This gives five hours of screen development, which should be adequate to investigate most target penetration tactics. At the end of the file creation, one final call to USEN is in order to change the configuration numbers to the ones indicated in the above table. This is purely a matter of convenience, because the configuration number does not enter into any SCREEN computations. The steps to do this are as follows.

```
SELECT MODE (HELP GIVES LIST): USEN
ENTER KEY (14 GIVES LIST): 10
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 1,20
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 2,11
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 3,21
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 4,10
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 5,20
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 6,12
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 7,22
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 8,10
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 9,20
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 10,11
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 11,21
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 12,10
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 13,20
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 14,12
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 15,22
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 16,10
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 17,20
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 18,11
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 19,21
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 20,10
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 21,20
ENTER TIME STEP, CONFIG. NO.(0=EXIT): 0,10
ENTER KEY (14 GIVES LIST): 0
```

The effect of these changes can be seen by listing the sensor parameters with the LSEN option. The listings for time steps 18 and 20 are shown below.

FIGURE V-21

A TYPICAL SENSOR SCREEN

CONFIGURATION 11

SENSOR PARAMETERS AT TIME STEP 18 HOUR 00.04.30

SENS/GRP			TYPE	COORDINATES n.m.	n.m.	SPEED kts	HEADING deg	RD db	LE db	LE CONTOUR	PROP LOSS	LAM #/hr	SIG db	NOIS INDX	CORR	RATE min	TIMINT min	AVAIL
1	1	Surf. Act. Escort	A	5.0	95.0	20.0	0.0	10	25	5 Act. Surf.	5 SDCZ Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
2	2	Surf. Act. Escort	A	5.0	85.0	20.0	0.0	10	25	5 Act. Surf.	5 SDCZ Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
3	3	Surf. Act. Escort	A	-5.0	95.0	20.0	0.0	10	25	5 Act. Surf.	5 SDCZ Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
4	4	Surf. Act. Escort	A	-5.0	85.0	20.0	0.0	10	25	5 Act. Surf.	5 SDCZ Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
5	5	Omni Sonobuoy	O	-20.0	100.0	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
6	5	Omni Sonobuoy	O	-20.0	95.0	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
7	5	Omni Sonobuoy	O	-20.0	90.0	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
8	5	Omni Sonobuoy	O	-20.0	85.0	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
9	5	Omni Sonobuoy	O	-17.5	97.5	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
10	5	Omni Sonobuoy	O	-17.5	92.5	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
11	5	Omni Sonobuoy	O	-17.5	87.5	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
12	5	Omni Sonobuoy	O	-17.5	82.5	30.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
13	13	Omni Sonobuoy	P	17.5	97.5	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
14	13	Omni Sonobuoy	P	17.5	92.5	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
15	13	Omni Sonobuoy	P	17.5	87.5	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
16	13	Omni Sonobuoy	P	17.5	82.5	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
17	13	Omni Sonobuoy	P	20.0	100.0	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
18	13	Omni Sonobuoy	P	20.0	95.0	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
19	13	Omni Sonobuoy	P	20.0	90.0	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
20	13	Omni Sonobuoy	P	20.0	85.0	0.0	0.0	5	0	2 n.b. Buoy	2 SDCZ n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
21	21	SSI Narrowband	P LA	0.0	140.0	10.0	0.0	15	30	1 n.b. Line	1 DDCZ n.b.	1.0	5.0	1	0.25	5.00	5.00	0.95
22	21	SSI Broadband	P	0.0	140.0	10.0	0.0	-10	10	3 b.b. Hull	3 DDCZ b.b.	1.0	5.0	2	0.25	1.00	1.00	0.90
23	23	SSN Narrowband	O	-50.0	130.0	30.0	0.0	15	30	1 n.b. Line	1 DDCZ n.b.	1.0	5.0	1	0.25	5.00	5.00	0.95
24	23	SSI Broadband	O	-50.0	130.0	30.0	0.0	-10	10	3 b.b. Hull	3 DDCZ b.b.	1.0	5.0	2	0.25	1.00	1.00	0.90
25	25	SSN Narrowband	O	50.0	130.0	30.0	0.0	15	30	1 n.b. Line	1 DDCZ n.b.	1.0	5.0	1	0.25	5.00	5.00	0.95
26	25	SSI Broadband	O	50.0	130.0	30.0	0.0	-10	10	3 b.b. Hull	3 DDCZ b.b.	1.0	5.0	2	0.25	1.00	1.00	0.90

The names for the LE and RL curves are taken from the PROP file which was declared along with the SENS file prior to this listing.

FIGURE V-21 (CONTINUED)

SENSOR PLATFORM SOURCE LEVELS	1	2	3	4	5	6	7	8	9	10
1 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
2 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
3 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
4 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
5 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
6 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
7 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
8 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
9 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
10 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
11 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
12 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
13 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
14 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
15 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
16 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
17 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
18 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
19 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
20 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
21 SSN Narrowband	130	105	-999	-999	-999	-999	-999	-999	-999	-999
22 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
23 SSN Narrowband	145	120	-999	-999	-999	-999	-999	-999	-999	-999
24 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
25 SSN Narrowband	145	120	-999	-999	-999	-999	-999	-999	-999	-999
26 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999

FIGURE V-21 (CONTINUED)

A TYPICAL SENSOR SCREEN

CONFIGURATION 10

SENSOR PARAMETERS AT TIME STEP 20 HOUR 00.05.00

	SENS/GRP		TYPE	COORDINATES nm	nm	SPEED kts	HEADING deg	RD db	LE db	LE CONTOUR			PROP LOSS		#/hr	LAM db	SIG INDX	NOIS	CORR min	RATE min	TIMINT	AVAIL
1	1	Surf. Act. Escort	A	5.0	105.0	20.0	0.0	10	25	5	Act.	Surf.	5	SDCZ	Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
2	2	Surf. Act. Escort	A	5.0	95.0	20.0	0.0	10	25	5	Act.	Surf.	5	SDCZ	Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
3	3	Surf. Act. Escort	A	-5.0	105.0	20.0	0.0	10	25	5	Act.	Surf.	5	SDCZ	Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
4	4	Surf. Act. Escort	A	-5.0	95.0	20.0	0.0	10	25	5	Act.	Surf.	5	SDCZ	Act.	2.0	6.0	5	0.00	10.00	3.00	0.80
5	5	Omni Sonobuoy	P	-20.0	140.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
6	5	Omni Sonobuoy	P	-20.0	135.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
7	5	Omni Sonobuoy	P	-20.0	130.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
8	5	Omni Sonobuoy	P	-20.0	125.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
9	5	Omni Sonobuoy	P	-17.5	137.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
10	5	Omni Sonobuoy	P	-17.5	132.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
11	5	Omni Sonobuoy	P	-17.5	127.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
12	5	Omni Sonobuoy	P	-17.5	122.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
13	13	Omni Sonobuoy	P	17.5	97.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
14	13	Omni Sonobuoy	P	17.5	92.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
15	13	Omni Sonobuoy	P	17.5	87.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
16	13	Omni Sonobuoy	P	17.5	82.5	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
17	13	Omni Sonobuoy	P	20.0	100.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
18	13	Omni Sonobuoy	P	20.0	95.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
19	13	Omni Sonobuoy	P	20.0	90.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
20	13	Omni Sonobuoy	P	20.0	85.0	0.0	0.0	5	0	2	n.b.	Buoy	2	SDCZ	n.b.	1.0	9.0	1	0.50	1.00	5.00	0.75
21	21	SSN Narrowband	P LA	0.0	150.0	10.0	0.0	15	30	1	n.b.	Line	1	DDCZ	n.b.	1.0	5.0	1	0.25	5.00	5.00	0.95
22	21	SSN Broadband	P	0.0	150.0	10.0	0.0	-10	10	3	b.b.	Hull	3	DDCZ	b.b.	1.0	5.0	2	0.25	1.00	1.00	0.90
23	23	SSN Narrowband	O	-50.0	140.0	30.0	0.0	15	30	1	n.b.	Line	1	DDCZ	n.b.	1.0	5.0	1	0.25	5.00	5.00	0.95
24	23	SSN Broadband	O	-50.0	140.0	30.0	0.0	-10	10	3	b.b.	Hull	3	DDCZ	b.b.	1.0	5.0	2	0.25	1.00	1.00	0.90
25	25	SSN Narrowband	O	50.0	110.0	30.0	0.0	15	30	1	n.b.	Line	1	DDCZ	n.b.	1.0	5.0	1	0.25	5.00	5.00	0.95
26	25	SSN Broadband	O	50.0	110.0	30.0	0.0	-10	10	3	b.b.	Hull	3	DDCZ	b.b.	1.0	5.0	2	0.25	1.00	1.00	0.90

FIGURE V-21 (CONTINUED)

SENSOR PLATFORM SOURCE LEVELS	1	2	3	4	5	6	7	8	9	10
1 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
2 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
3 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
4 Surf. Act. Escort	150	115	-999	-999	-999	-999	-999	-999	-999	-999
5 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
6 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
7 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
8 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
9 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
10 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
11 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
12 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
13 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
14 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
15 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
16 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
17 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
18 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
19 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
20 Omni Sonobuoy	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
21 SSN Narrowband	130	105	-999	-999	-999	-999	-999	-999	-999	-999
22 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
23 SSN Narrowband	145	120	-999	-999	-999	-999	-999	-999	-999	-999
24 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
25 SSN Narrowband	145	120	-999	-999	-999	-999	-999	-999	-999	-999
26 SSN Broadband	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999

Target File Definition

Next we will consider the development of target files which describe target strategy against the above screen. The first target which we define starts from a position ahead of the task force and attempts to penetrate to an attack circle which is defined as a 2.5 mile circular spa centered 20 miles ahead of the carrier. Since the submarine escorts must sprint at high speed to maintain PIM, it is assumed that the target will attempt to detect and evade the center SSN. After some preliminary calculations, the following sequence of inputs is generated. Commentary will follow the blocks of input.

```
OK, SEG SCREEN
ENTER ACOUSTIC DATA FILE NO. (1-99): 0
ENTER SENSOR FILE NUMBER (1-99): 0
ENTER TARGET FILE NO. (1- 99): 50
ENTER DELTA T (hrs): .25
ENTER TARGET LABEL: DOGLEG FROM AHEAD
```

It is generally wise to create target files without declaring a SENS file, as shown here. The reason is that the target file creation will generally involving time stepping and this may alter the contents of a SENS file if one is declared. The value of DELTA T must be the same as for any sensor file intended for use with this target file.

```
ENTER INITIAL TARGET COORD (X,Y) (nm): 0,210
ENTER INITIAL TARGET SPA PARAMETERS
  2 SIG S-MAJ AXIS,S-MIN AXIS(nm), BRG OF MAJ(deg): 5,5,0
ENTER TARGET MOTION PARAMETERS
     TARGET VEL CHANGE RATE (#/hr): 1
     MEAN TARGET SPEED (kts), HEADING (deg): 21,170
     STD DEV IN TGT SPEED (kts), HEADING (deg): 2,10
ENTER TGT NOISE INDEX AND LEVEL (db)(0=Exit): 1,155
ENTER TGT NOISE INDEX AND LEVEL (db)(0=Exit): 2,120
ENTER TGT NOISE INDEX AND LEVEL (db)(0=Exit): 5,10
ENTER TGT NOISE INDEX AND LEVEL (db)(0=Exit): 0
ENTER TARGET FILE NO. (1- 99): 0
ENTER FILENAME FOR OUTPUT (C for console): DOGLEG.AHEAD
APPEND TO PRESENT FILE (Y OR N): N
```

The initial position, course, and speed are designed to end up about 15 miles to one side of the center SSN escort. The velocity statistics are somewhat arbitrarily chosen to give some variation in the sample paths. The noise levels correspond to the estimated mean values of target radiated noise. Index 1 is the narrowband value detectable by the sonobuoys and SSN narrowband sonar. Index 2 is the broadband noise detectable by the SSN broadband sensor. Index 5 is the active target strength. We chose to place output in a file named DOGLEG.AHEAD.

The first change in tactic occurs at timestep 16, when the SSN threat pulls abreast of the SSN escorts.

```
******************************

SELECT MODE (HELP GIVES LIST): TSTEP
ENTER NEW PROGRAM TIME STEP: 16

******************************

SELECT MODE (HELP GIVES LIST): UTAR
ENTER TARGET NO.: 50
ENTER KEY (6 GIVES LIST): 6
 0 = POP OUT
 1 = CHANGE TARGET LABEL
 2 = UPDATE VELOCITY CHANGE RATE
 3 = UPDATE SPEED AND HEADING
 4 = UPDATE STANDARD DEVIATION IN TARGET SPEED AND HEADING
 5 = UPDATE INDEX AND LEVEL
ENTER KEY (6 GIVES LIST): 3
ENTER NEW TARGET SPEED (kts) ,HEADING (deg): 19,235
ENTER NEW STD. DEV. IN TGT SPEED (kt),HEADING (deg): 0,0
ENTER KEY (7 GIVES LIST): 0
ENTER TARGET ID.: 0
```

After four hours the target is ready to turn to the final leg. For this part of the track, we pick a speed and course which will reach attack position at hour five (step 20). The speed and heading are given zero variance because it is desirable on this part of the track to deviate from a straight run-in as little as possible.

```
******************************

SELECT MODE (HELP GIVES LIST): TSTEP
ENTER NEW PROGRAM TIME STEP: 20

******************************

SELECT MODE (HELP GIVES LIST): LTAR
ENTER START,STOP STEPS (0 - 20): 0,20
```

(Only part of the output of this step is shown)

FIGURE V-22

TARGET PARAMETERS

TARGET PARAMETERS AT STEP 0 HOUR 00.00.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	0.0	210.0	21.0	2.0	170.0	10.0	1.0	5.0	5.0	45.0	155	120	-199	-199	10
	0.0R	210.0R	21.0R		170.0R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 4 HOUR 00.01.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	3.6	189.3	21.0	2.0	170.0	10.0	1.0	3.1	6.1	80.0	155	120	-199	-199	10
	3.6R	189.3R	21.0R		170.0R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 8 HOUR 00.02.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	7.3	163.6	21.0	2.0	170.0	10.0	1.0	12.2	7.9	80.0	155	120	-199	-199	10
	7.3R	163.6R	21.0R		170.0R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 12 HOUR 00.03.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	10.9	143.0	21.0	2.0	170.0	10.0	1.0	15.7	9.6	80.0	155	120	-199	-199	10
	10.9R	143.0R	21.0R		170.0R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 16 HOUR 00.04.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	14.6	127.3	12.0	0.0	235.0	0.0	1.0	18.8	11.1	80.0	155	120	-199	-199	10
	14.6R	127.3R	12.0R		235.0R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 20 HOUR 00.05.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	-1.0	116.4	12.0	0.0	235.0	0.0	1.0	20.5	11.9	80.0	155	120	-199	-199	10
	-1.0R	116.4R	12.0R		235.0R						-199	-199	-199	-199	-199

Note that the spa has expanded with time as one would expect from any unconstrained diffusion process. The final position at step 20 is approximately at the attack position, but should be adjusted. To focus the tracks exactly on the attack circle, a marginal constraint is applied at the attack time. This is done as follows.

```
SELECT MODE (HELP GIVES LIST): MARGE
INPUT TARGET FILE NO.: 50
INPUT CONSTRAINT TIME STEP: 20
ENTER CONSTRAINT COORDINATES (X,Y) (nm): 0,120
ENTER TARGET CONSTRAINT PARAMETERS:
1-SIG S-MAJ, S-MIN AXIS (nm), MAJ AXIS BRG (deg): 2.5,2.5,0
DO YOU VERIFY CONSTR. PARAMETERS (Y OR N): Y
```

The result of the marginal constraint is seen in the following selected LTARs.

FIGURE V-23

TARGET PARAMETERS AFTER CONSTRAINT

TARGET PARAMETERS AT STEP 0 HOUR 00.00.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	-0.0	210.6	20.6	2.0	159.4	10.2	1.0	4.9	4.6	80.0	155	120	-199	-199	10
	-0.0R	210.6R	20.6R		159.4R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 4 HOUR 00.01.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	3.8	190.5	20.4	2.0	169.0	10.3	1.0	6.5	4.7	80.0	155	120	-199	-199	10
	3.8R	190.5R	20.4R		169.0R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 8 HOUR 00.02.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	7.7	170.5	20.3	2.0	168.9	10.3	1.0	7.8	4.9	80.0	155	120	-199	-199	10
	7.7R	170.5R	20.3R		168.9R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 12 HOUR 00.03.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	11.6	150.6	20.3	2.0	169.0	10.3	1.0	6.9	4.2	80.0	155	120	-199	-199	10
	11.6R	150.6R	20.3R		169.0R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 16 HOUR 00.04.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	15.5	130.6	13.7	0.0	235.7	0.0	1.0	2.2	1.6	-10.0	155	120	-199	-199	10
	15.5R	130.6R	13.7R		235.7R						-199	-199	-199	-199	-199

TARGET PARAMETERS AT STEP 20 HOUR 00.05.00
"R" = RELATIVE TO PIM = (0.0, 0.0) PIM COURSE 90.0 PIM SPEED 0.0

TARGET	COORDINATES nm	nm	SPEED kts	S.D. kts	HEADING deg	S.D. deg	VEL CHG #/hr	2-SIGMA nm	COV nm	AXIS degs	SOURCE LEVELS 1	2	3	4	5
50 DOGLEG FROM AHEAD	[illegible]	120.0	12.0	0.0	235.0	0.0	1.0	2.5	2.5	[illegible]	155	120	-199	-199	10
	[illegible]	120.0R	12.0R		235.0R						-199	-199	-199	-199	-199

Note that the marginal is exactly reproduced at step 20. The target turns the corner at time 16 from a very tight spat this occurs because the velocity variances were set to zero for this leg. The parameters at time zero are altered very slightly. Between time zero and step 16, the target tracks tend to 'bow out' due to the diffusion over this portion of the track.

The above example of a track generation is only one of many ways that target scenarios can be generated. By appropriate combinations of marginal constraints, posits and selections of diffusion parameters, it is possible to create almost any target evolution that is desired. With practice, considerable skill in generating target files can be gained.

CHAPTER VI

SCREEN ANALYSIS

This chapter looks at the various analysis options of the SCREEN program, using the data files created in Chapter V. First the PDSENS option will be examined, followed by PDSTEP and the various CDP options. To conserve space, most of the maps have been vertically condensed.

PDSENS -- Sensor Coverage Maps

The first step in a screen analysis is to see the coverage of the different screen sensors. Logically, of course, this coverage is a fundamental input to determining the placement of the screen elements. In fact, the SENS file described in Chapter V was developed in two steps. First, a SENS file was created only at time step 0 (zero) which had the correct performance characteristics of each type of sensor, but arbitrary sensor locations. Using this SENS file, the individual sensor coverage was examined and a screen formation was decided upon. Second, the SENS file as described in Chapter V was created.

The commands to generate a sensor coverage map are as follows:

```
OK, SEG SCREEN
ENTER ACOUSTIC DATA FILE NO. (1-99): 2
ENTER SENSOR FILE NUMBER (1-99): 1
ENTER TARGET FILE NO. (1- 99): 50
ENTER TARGET FILE NO. (1- 99): 0

ENTER FILENAME FOR OUTPUT (C for console): C

SELECT MODE (HELP GIVES LIST): PDSEN
ENTER START,STOP STEPS (0 - 21): 8,8
ENTER SENSOR NO.: 1
ENTER TARGET SOURCE LEVEL (db): 10
ENTER GRID SPACING (nm): 5
```

The following figures show the sensor coverage maps for each of the sensor types included in the screen. Since sensor 1 is an active sensor, the appropriate target source level (target strength) for active detection was input.

FIGURE VI-1

ACTIVE SONAR PDSEN

MARKED ON FIG. JAN 24 1980 AT 7HR 5MIN 1.5SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

SENSOR LABEL: Surf. Act. Escort
SENSOR S/H: 20.0 KNOTS AT 0.0 DEGREES
TARGET LEVEL: 10.0
SENSOR NUMBER: 1
TIME STEP: 5
PROPAGATION LOSS LABEL 5 IS: SOCZ Act.
DISTANCE BETWEEN GRID POINTS: 5.0 N.M.

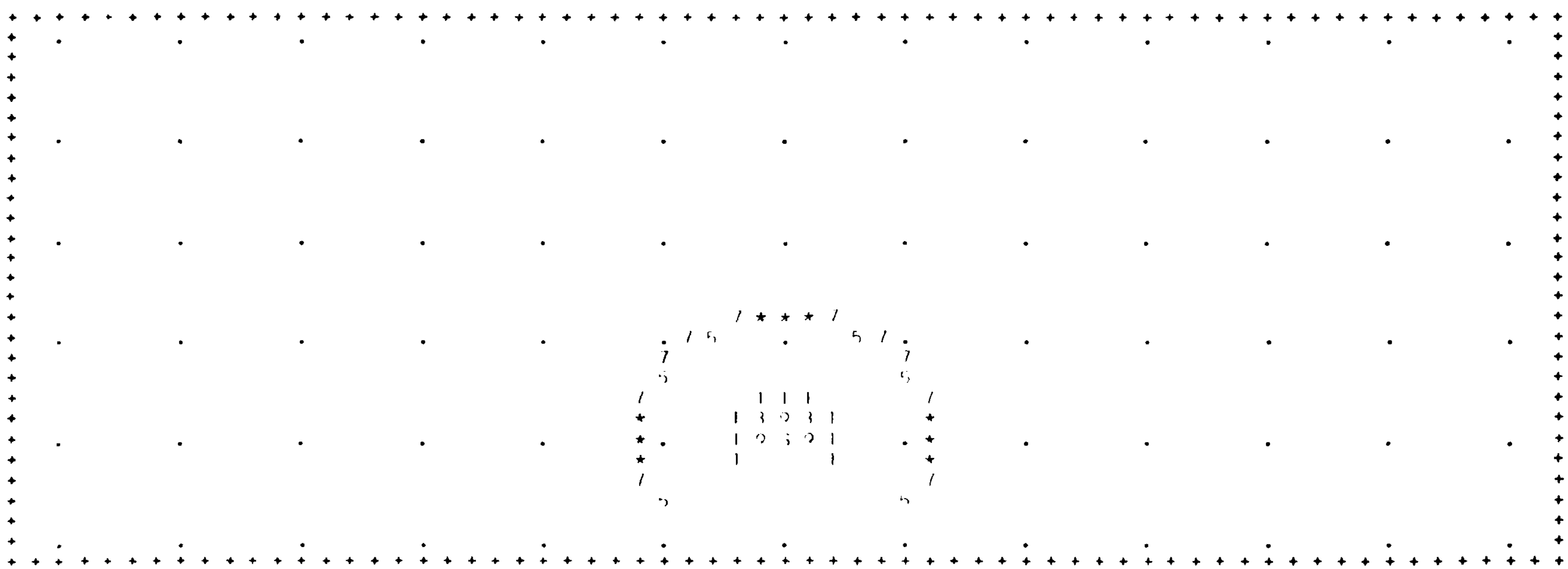


Figure VI-1 shows the coverage around each of the surface escorts provided by their active sonar. The 'S' represents the ship's location. The interpretation of this picture is that there is a .9 probability of detecting a target within 5-6 miles of the ship. Of course, if the target is in the baffle it would not be detected, as is indicated by the 'blanks', no coverage, behind (these PDSEN pictures assume the sensor is headed north.) The figure also shows good detection capablity (.7 to .99) in a first convergence zone (CZ) about 30 miles from the ship. The difference in detection values in the CZ is due to the range differences in the grid points on the map from the ship and the variation in propagation loss within the CZ.

FIGURE VI-2

SSN NARROWBAND PDSEN

MARKED ON FRI, JAN 24 1980 AT 7HR 5MIN 36.14SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

SENSOR LABEL: SSN Narrowband
SENSOR S/H: 10.0 KNOTS AT 0.0 DEGREES
TARGET LEVEL: 155.0
SENSOR NUMBER: 21
TIME STEP: 3
PROPAGATION LOSS LABEL 1 IS: POCZ n.p.
DISTANCE BETWEEN GRID POINTS: 6.0 N.M.

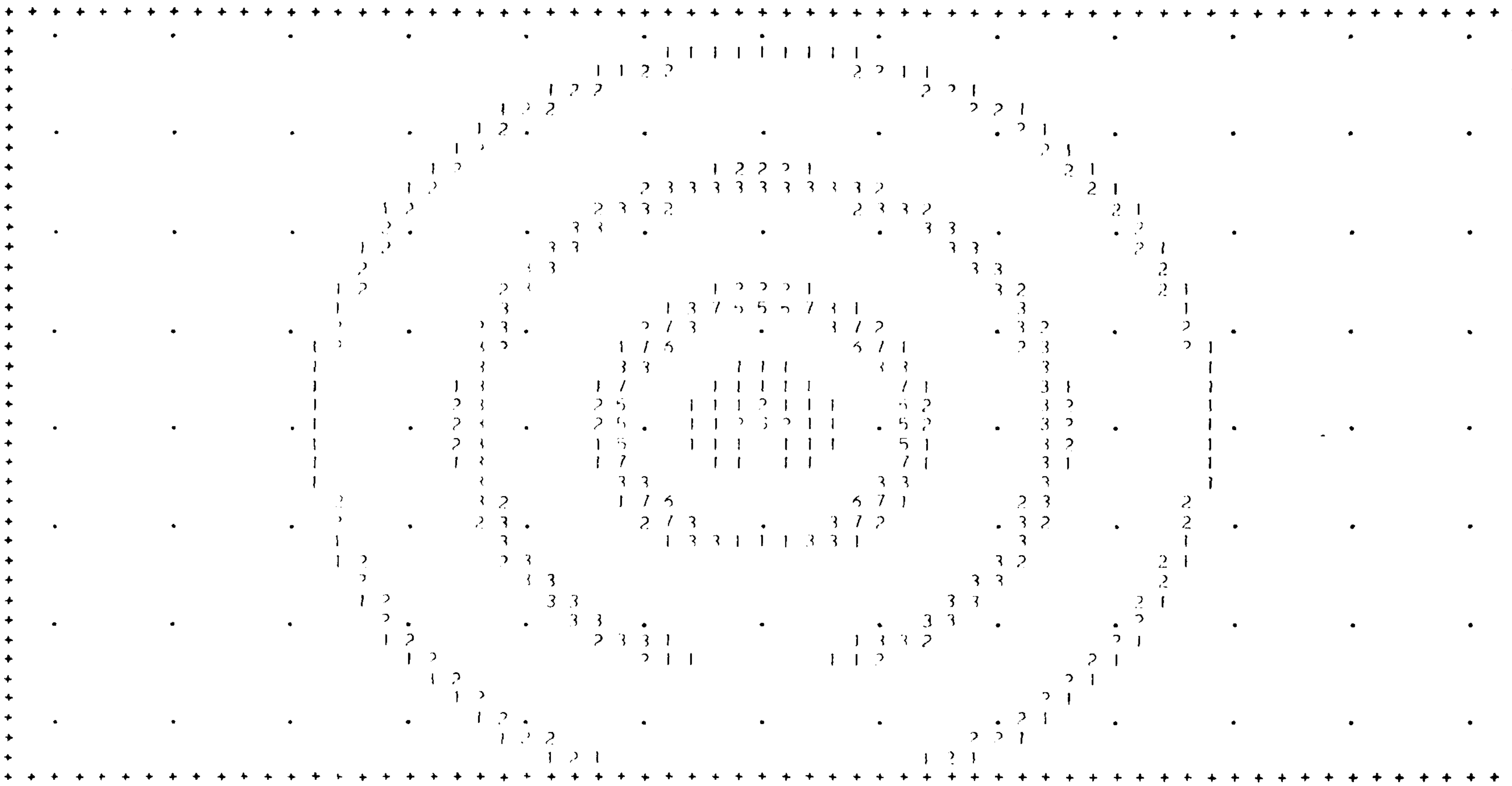


Figure VI-2 shows the coverage of the SSN line array. It indicates poor direct path range (less than 5 miles), but good first CZ coverage, and some capability even in the third CZ. The slight increase in self-noise in the direction of the SSN has not affected the coverage, which indicates that this sensor is ambient noise limited. The lack of coverage behind this sensor is not a baffle (there is none on the line array) but rather the effect of interfering noise created by the HVU and its surface escorts.

FIGURE VI-3

SSN BROADBAND POSEN

MARK-? ON THU, JAN 24 1980 AT 7HR 5MIN 24.14SEC D.H. WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3
I-5

SENSOR LABEL: SSN Broadband
SENSOR S/H: 10.0 KNOTS AT 0.0 DEGREES
TARGET LEVEL: 120.0
SENSOR NUMBER: 22
TIME STEP: 5
PROPAGATION LOSS LABEL 3 IS: DOCZ 5.5.
DISTANCE BETWEEN GRID POINTS: 5.0 N.M.

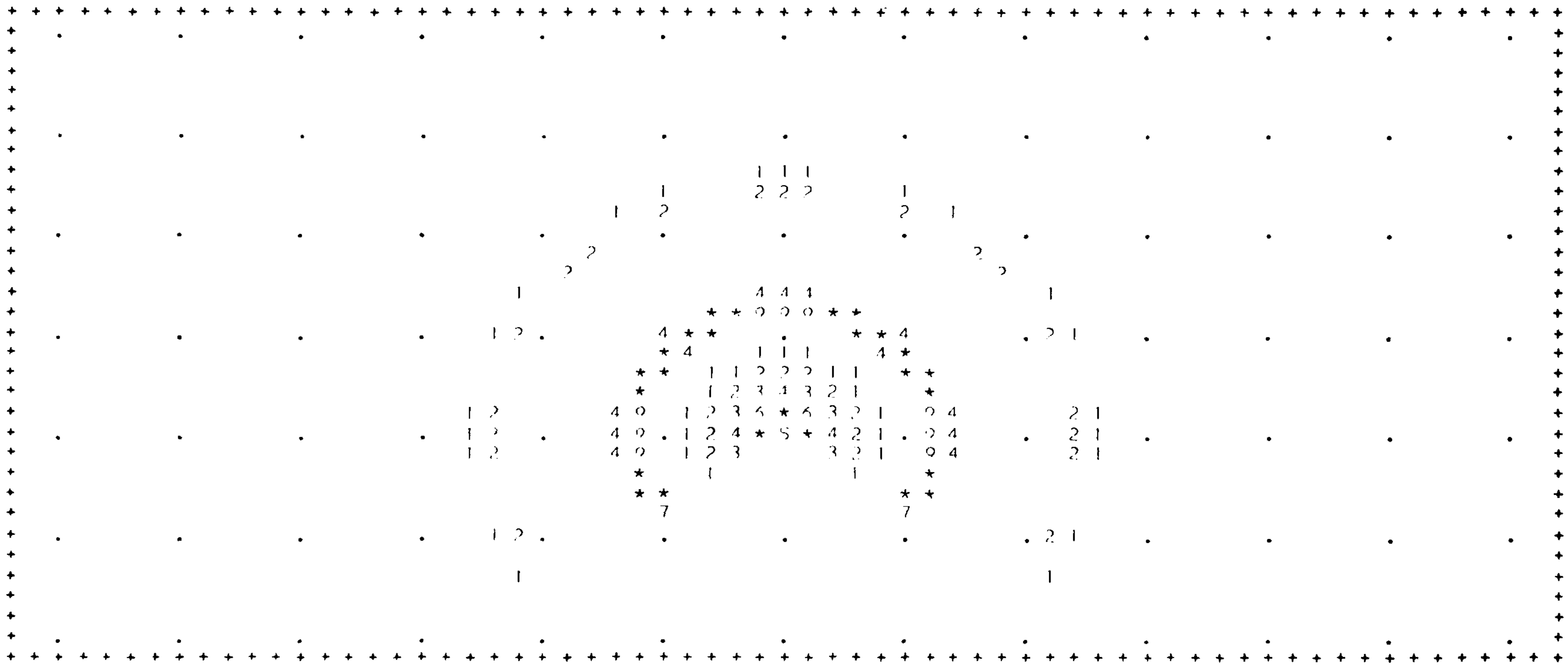


Figure VI-3 shows the SSN broadband coverage. It illustrates the lack of coverage in the baffles. The detection coverage may be described as direct path range of 6-7 miles, strong first CZ coverage, weak second CZ coverage, and no third CZ coverage.

FIGURE VI-4

SONOBUOY POSEN

MARKED ON THU, JAN 24 1980 AT 7HR 6MIN 55.41SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

SENSOR LABEL: Omni Sonobuoy
SENSOR S/H: 0.0 KNOTS AT 0.0 DEGREES
TARGET LEVEL: 155.0
SENSOR NUMBER: 10
TIME STEP: 3
PROPAGATION LOSS LABEL 2 IS:SDCZ n.b.
DISTANCE BETWEEN GRID POINTS: 5.0 N.M.

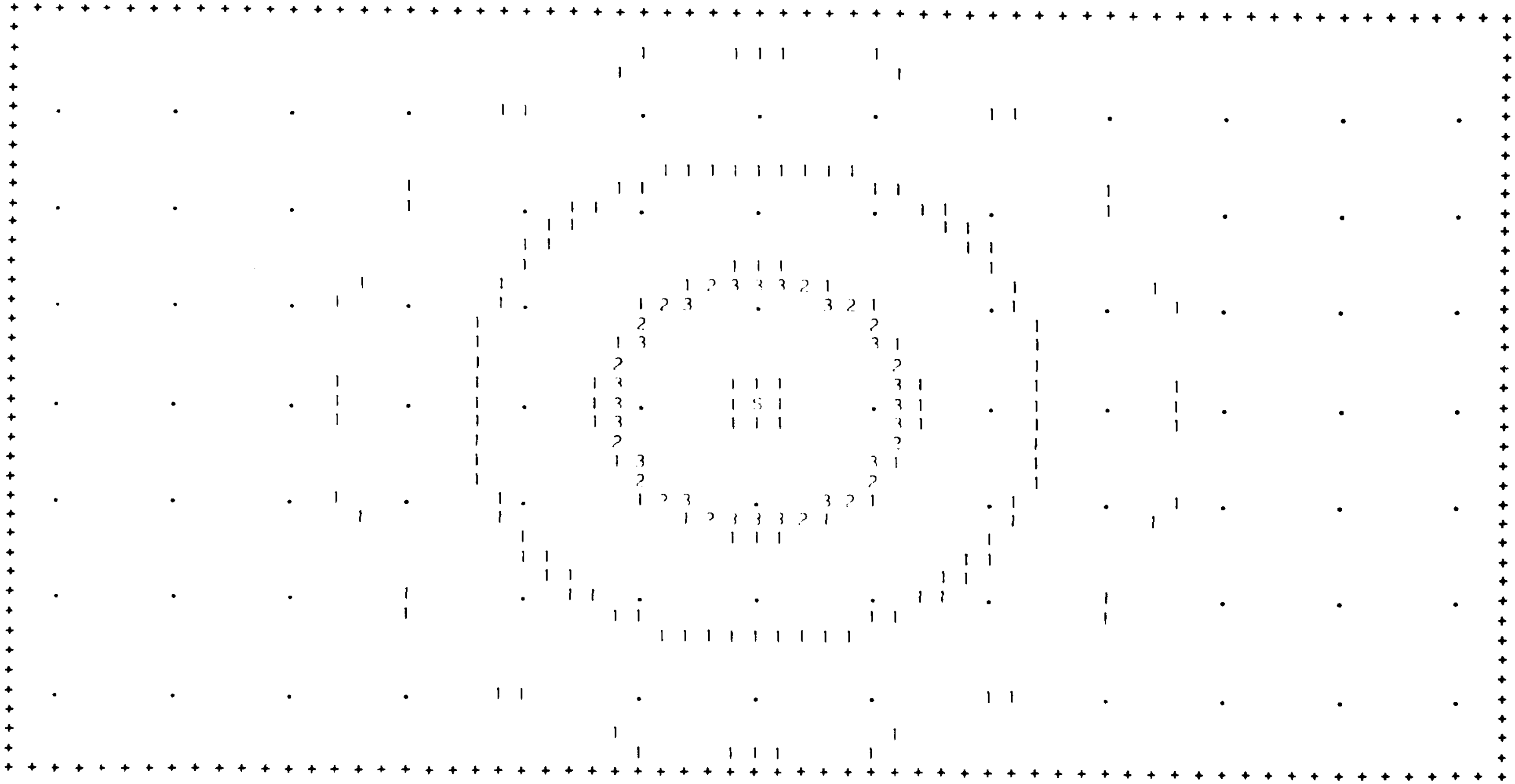


Figure VI-4 is a map of a single sonobuoy's coverage. It may be compared with the attempt of the SSN to detect the same signal. The differences in coverage are due to the changes in propagation loss between a shallow (sonobuoy) sensor and a deep (SSN) sensor and changes in the sonar equation parameters defining each system.

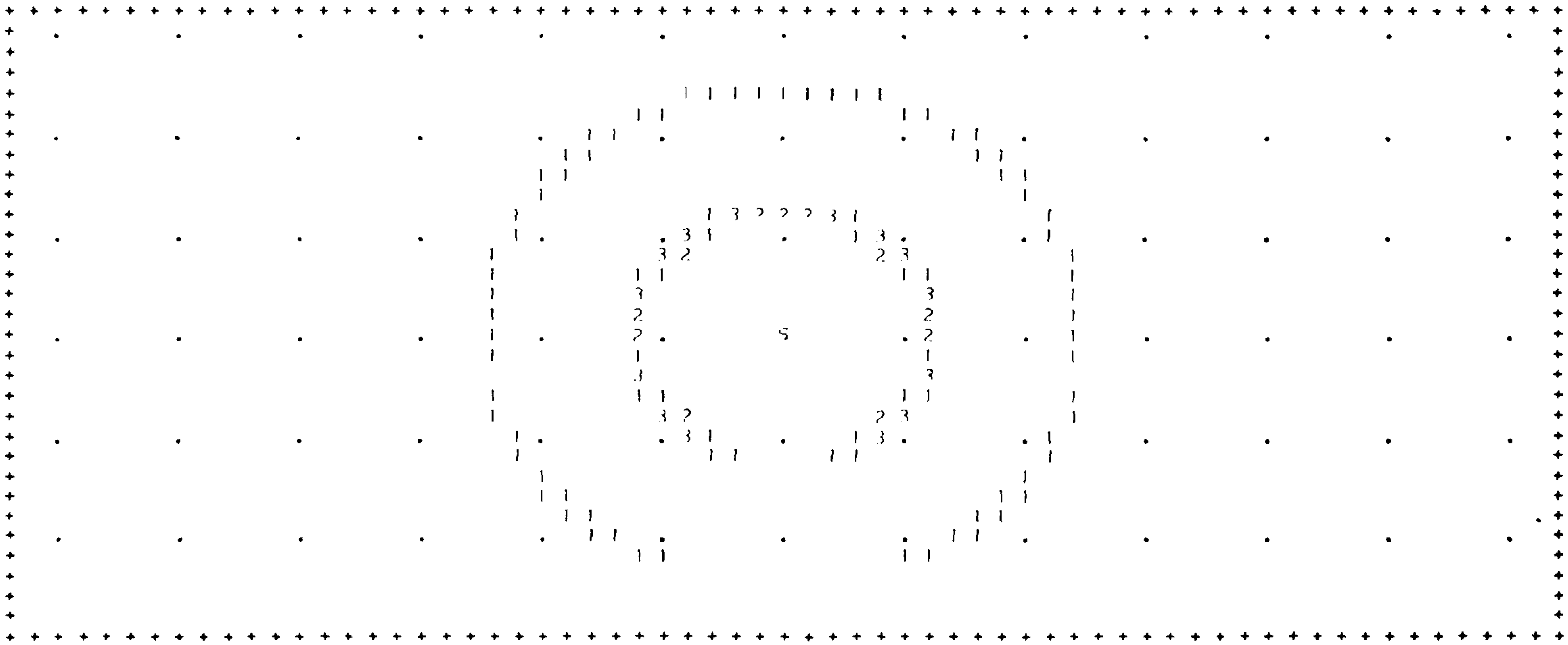
The above coverage maps are for the radiated noise levels used in the target file. It is possible to use the PDSENS option to test the effect of variations in this noise level. The following map is for the SSN narrowband with a 5 db reduction in target radiated noise.

FIGURE VI-5

SSN NARROWBAND PDSEN WITH REDUCED SOURCE LEVEL

MARKED ON THU, JAN 24 1980 AT 7HR 7MIN 20.95SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

SENSOR LABEL: SSN Narrowband
SENSOR S/H: 10.0 KNOTS AT 0.0 DEGREES
TARGET LEVEL: 150.0
SENSOR NUMBER: 21
TIME STEP: 8
PROPAGATION LOSS LABEL IS: D-CZ n.p.
DISTANCE BETWEEN GRID POINTS: 5.0 N.M.



By comparing Figures VI-2 and VI-5, one notes that the SSN narrowband detection capability is very sensitive to a 5 db reduction in figure of merit (FOM). In this case, the FOM reduction resulted from a reduction in source level, but any changes in capability which result in a 5 db reduction in FOM would have the same effect. Observe that no third CZ coverage is indicated, that no direct path coverage is indicated (direct path coverage is less than 5 miles) and that the best detection opportunity in the first CZ is now reduced from a value of .7 to a value of .3.

PDSTEP -- Screen Coverage Maps

The screen coverage maps show the composite effect of all sensors in a group or screen. Since several distinct screen configurations are involved in this example, we will show a few of the cases. Both detection and localization maps are computed. Each example is followed by commentary on the maps.

The command sequence to produce PDSTEP maps is as follows.

****

```
SELECT MODE (HELP GIVES LIST): PDSTEP
ENTER START,STOP STEPS (0 - 21): 8,8
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER THE MAP LABEL: COVERAGE AT TIMESTEP EIGHT
DO YOU WANT INFORMATION MAPS (Y OR N): Y
ENTER TGT NOISE INDEX   LEVEL (db) (0=POPOUT): 1,155
ENTER TGT NOISE INDEX   LEVEL (db) (0=POPOUT): 2,120
ENTER TGT NOISE INDEX   LEVEL (db) (0=POPOUT): 5,10
ENTER TGT NOISE INDEX   LEVEL (db) (0=POPOUT): 0
ENTER GRID SPACING (nm): 5
ENTER SAMPLE TIME (min): 5
```

By entering group number zero (0) the entire screen is evaluated. The coverage maps for a particular sensor group could also be computed by entering the appropriate group number as shown in a LSENS listing. The following figures show the coverage maps for some of the interesting configurations.

FIGURE VI-6

PDSTEP AT TIME STEP 8

```
                              DETECTION PROBABILITY MAP
MARKED ON THU, JAN 24 1980 AT    7HR   39MIN  40.11SEC     D.H.WAGNER ASSOCIATES

TIME STEP:      8
PIM S/H: 20.0 KNOTS AT   0.0 DEGREES   PIM COORDS X=    0.0 Y=  40.0
PROPAGATION LOSS LABEL  5 IS:SDCZ Act.
DISTANCE BETWEEN GRID POINTS:  5.00 N.M.

SAMPLE TIME:  5.00 MINUTES
GROUP NUMBER FOR THIS MAP (0=ENTIRE SCREEN) IS    0
```

FIGURE VI-6 (CONTINUED)

FAMO ? SOURCE LEVELS USED IN THIS MAP: INDEX 1 2 3 4 5 6 7 8 9 10
155 120-229-229 10-229-229-229-229-229

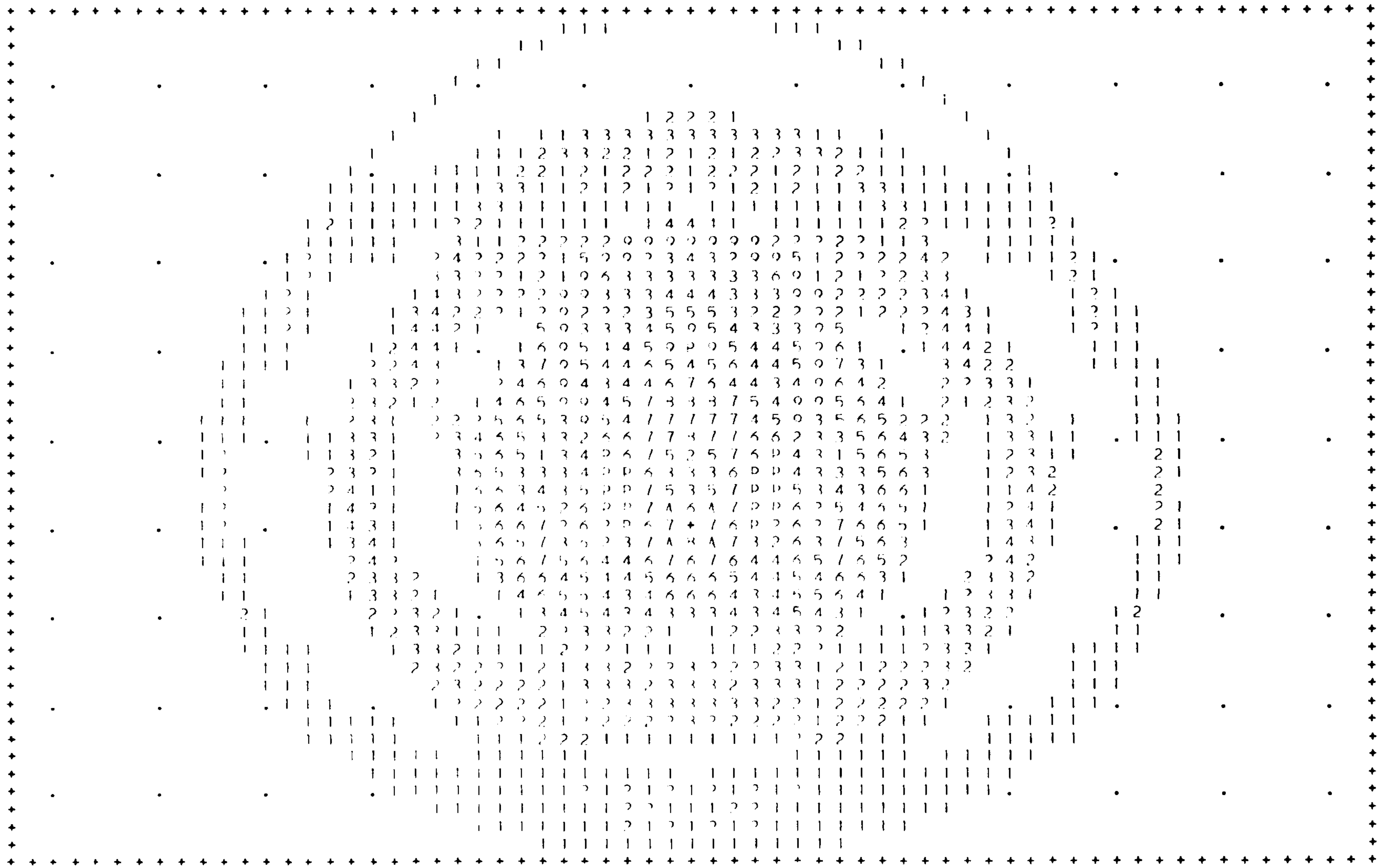


FIGURE VI-6 (CONTINUED)

LOCALIZATION GIVEN DETECTION

MARKED ON THU, JAN 31 1980 AT 7HR 42MIN 39.17SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

TIME STEP: 8
PIM S/H: 20.0 KNOTS AT 0.0 DEGREES PIM COORDS X= 0.0 Y= 40.0
PROPAGATION LOSS LABEL 5 IS: SCZ Act.
DISTANCE BETWEEN GRID POINTS: 5.00 N.M.

SAMPLE TIME: 5.00 MINUTES
GROUP NUMBER FOR THIS MAP (0=ENTIRE SCREEN) IS 0

TARGET SOURCE LEVELS USED IN THIS MAP: INDEX 1 2 3 4 5 6 7 8 9 10
155 120-999-999 10-999-999-999-999-999

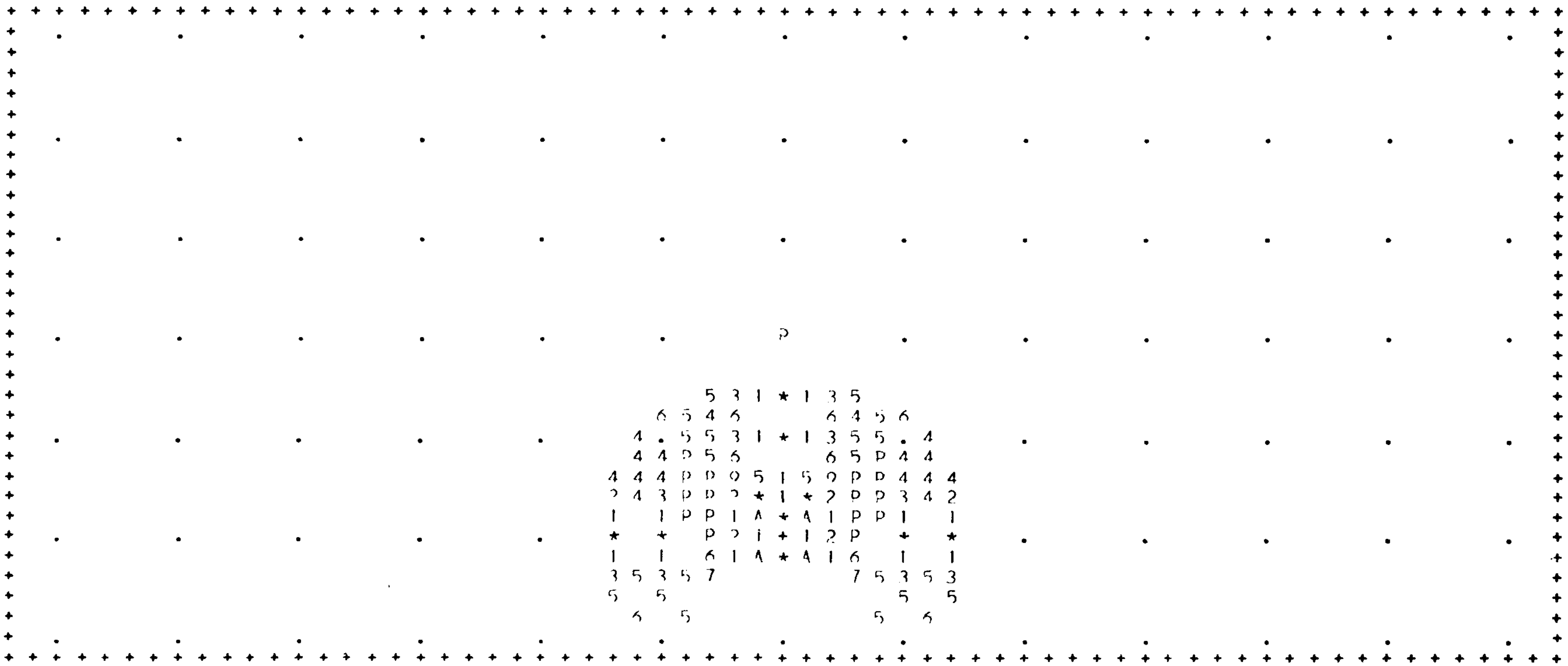


FIGURE VI-7

POSTED AT TIME STEP 3

```
                                        [illegible] PROBABILITY MAP
MARKED [illegible] FRI, JAN [illegible] 1980 A. [illegible] TIME [illegible]        D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

TIME STEP:       3
PIM SIZE: [illegible].0 KNOTS AT   0.3 DEGREES   PIM COORDS, X=   0.0 Y=  15.0
PROPAGATION LOSS LABEL  5 IS: [illegible] Act.
DISTANCE BETWEEN GRID POINTS:  5.00 N.M.

SAMPLE TIME:  5.00 MINUTES
GROUP [illegible] FOR THIS MAP (0=ENTIRE SCREEN) IS  0
```

FIGURE VI-7 (CONTINUED)

TARGET SOURCE LEVELS USED IN THIS MAP: INDEX 1 2 3 4 5 6 7 8 9 10
155 120-999-999 10-999-999-999-999-999
COVERAGE AT [illegible] THREE

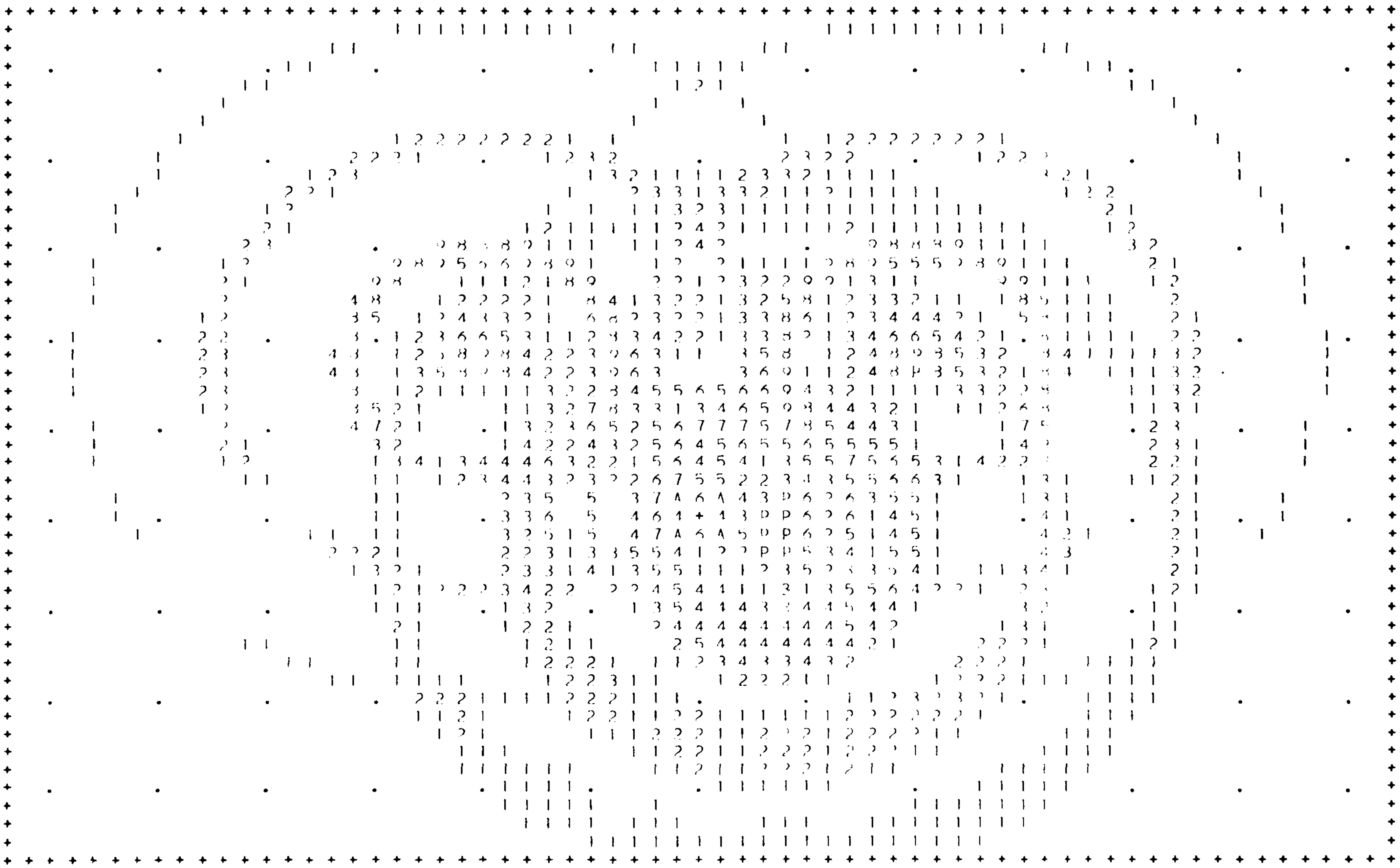


FIGURE VI-7 (CONTINUED)

LOCALIZATION GIVEN DETECTION

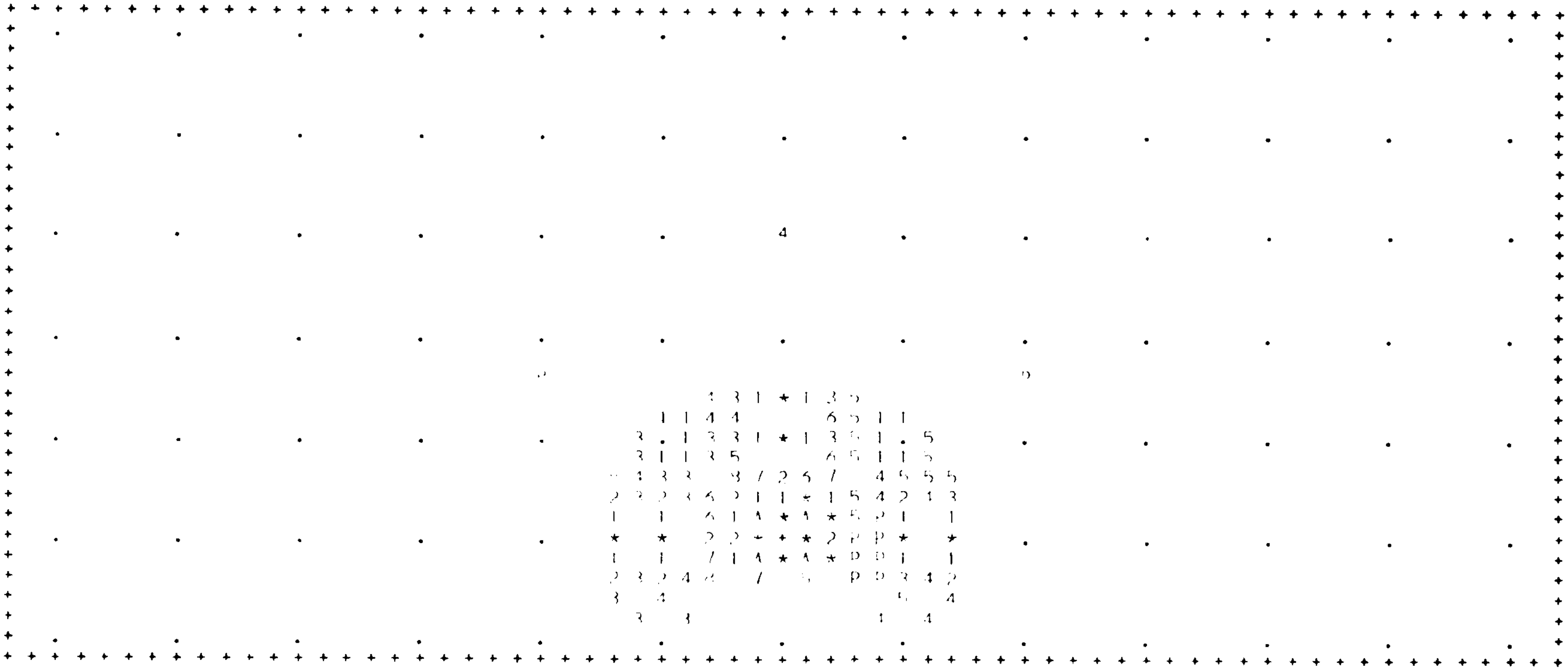
MARKED ON THU, JAN 24 1980 AT 7HR 47MIN 0.12SEC D.I. WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

TIME STEP: 3
PIM S/H: 20.0 KNOTS AT 0.0 DEGREES PIM COORD. X= 0.0 Y= 15.0
PROPAGATION LOSS LABEL 5 IS:SIOX Act.
DISTANCE BETWEEN GRID POINTS: 5.00 N.M.

SAMPLE TIME: 5.00 MINUTES
GROUP NUMBER FOR THIS MAP (0=ENTIRE SCREEN) IS 0

TARGET SOURCE LEVELS USED IN THIS MAP: INDEX 1 2 3 4 5 6 7 8 9 10
155 120-999-999 10-999-999-999-999-999

COVERAGE AT TIMESTEP THREE



The second coverage map is for timestep 3, at which time the port sonobuoy field is being relaid and does not contribute to coverage. The flanking escort submarines are searching but the center SSN is sprinting. The localization map for this case shows that the SSNs provide some localization potential where their second convergence zones intersect. The bulk of the localization is provided by the surface active escorts. Note that the localization coverage is not symmetric. This is due to the contribution of the starboard sonobuoy field. At first sight it might seem surprising that the localization map is not symmetric, particularly since the sonobuoys are omnidirectional and therefore do not contribute to localization in the SCREEN program. The reason for the nonsymmetric localization coverage is that the quantity shown is the conditional quantity--localization given detection. If the detection and localization maps are compared at symmetric points where the localization coverage is not the same, it will be discovered that the detection probability is higher where the localization coverage number is larger. The product of the probability of detection and the localization given detection is the same to the nearest integer. To be specific, consider the symmetric positions (25,-10) and (-25,-10). At the position (25,-10), the probability of detection is .5 and the localization is three miles. At the position (-25,-10), the probability of detection is .4 and the localization is two miles. The lower detection probability event produces a better localization given detection.

Cumulative Performance Measures

Finally, we will exercise options CDPL and MAPL with target 50. The results are as follows.

```
SELECT MODE (HELP GIVES LIST): CDPL
ENTER START, STOP STEPS(1 - 20): 1,20
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER STEPS OF FLOW (>=0): 20
ENTER TARGET FILE NO.  (1-99): 50
ENTER TARGET FILE NO.  (1-99): 0
ENTER NO. OF POINTS PER FLOW (1,9,25 OR 49): 1
```

The first interesting results occur after time step 16, and so only these will be shown.

*** TIME STEP NUMBER 16 ***

CDP*10,000 BY SENSOR GROUP AND FLOW

GROUP		1	2	3	4	5	13	21	23	25
TARG	DELAY									
50	0	0	0	0	0	4735	1721	3775	1350	1662
50	1	0	0	0	0	4690	1141	9128	201	1974
50	2	0	0	0	0	3252	266	9108	1005	3193
50	3	0	0	0	0	598	0	2820	370	373
50	4	0	0	0	0	1582	0	951	0	2217
50	5	0	0	0	0	2818	0	1551	1178	2004
50	6	0	0	0	0	1494	0	2259	0	938
50	7	0	0	0	0	140	0	166	1060	0
50	8	0	0	0	0	0	0	0	110	893
50	9	0	0	0	0	0	0	501	0	11
50	10	0	0	0	0	0	0	0	0	0
50	11	0	0	0	0	0	0	0	0	0
50	12	0	0	0	0	0	0	0	0	0
50	13	0	0	0	0	0	0	0	0	0
50	14	0	0	0	0	0	0	0	0	0
50	15	0	0	0	0	0	0	0	0	0
50	16	0	0	0	0	0	0	0	0	0
50	17	0	0	0	0	0	0	0	0	0
50	18	0	0	0	0	0	0	0	0	0
50	19	0	0	0	0	0	0	0	0	0
50	20	0	0	0	0	0	0	0	0	0

This display shows the value of cdp for each sensor group and each flow delay timestep. By examining this table, the effect of each group can be seen. The later flows have not yet begun to suffer attrition, whereas the zero flow is about to enter the active screen coverage. The numbers are cdp*10000. The screen cdp which appears next simply combines the group probabilities independently (i.e. the screen failure probability is the product of the group failure probabilities which can be verified by direct calculation from this and the next table).

Groups 1 through 4 are the active escorts as seen from any LTAR in Chapter V. Group 5 is the port buoyfield, 13 is the starboard buoyfield, groups 23, 24, and 25 are the center, port, and starboard SSN escorts. The port buoy field has a higher detection performance than the starboard buoy field simply because the circle of replacement is such that the port field was in a better position to detect at the time that the target approached detectable ranges. Note that for some of the delayed targets such as the 3 time step delay this phenomena reversed, i.e., the starboard field got the first detection opportunity. Since the targets have not yet entered into the coverage area of the active sonars, they have no detection capability indicated.

TARGET EVALUATION AT TIME STEP 16 HOUR 00.04.00

GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS 0

TARGET	TIME DELAY	CDP
50	0	0.805
50	1	0.964
50	2	0.964
50	3	0.375
50	4	0.407
50	5	0.572
50	6	0.403
50	7	0.133
50	8	0.099
50	9	0.051
50	10	0.000
50	11	0.000
50	12	0.000
50	13	0.000
50	14	0.000
50	15	0.000

PROBABILITY TARGET IS WITHIN XX nm OF PIM

XX = 10	20	30	40	50	60	70	80	90	100 nm
0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CDP FOR FLOW OF TARGET 50 IS 0.298

AVERAGE CDP FOR TARGETS IS 0.298

TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA Radius) .5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
50	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE OVER THESE PLOTS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE OVER ALL PLOTS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TARGET EVALUATION AT TIME STEP 18 HOUR 00.04.30
*** TIME STEP NUMBER 18 ***

CDP*10,000 BY SENSOR GROUP AND FLOW

GROUP		1	2	3	4	5	13	21	23	25
TARG	DELAY									
50	0	2447	0	0	0	4745	5639	4458	3340	1671
50	1	0	0	0	0	4917	4261	9158	3158	3288
50	2	0	0	0	0	4156	1655	9247	2706	5351
50	3	0	0	0	0	3254	2402	2979	2628	409
50	4	0	0	0	0	2951	3076	9198	707	2242
50	5	0	0	0	0	2937	1952	8961	1220	2004
50	6	0	0	0	0	2040	878	2804	0	938
50	7	0	0	0	0	1753	1298	166	1060	3004
50	8	0	0	0	0	1026	1291	2900	110	942
50	9	0	0	0	0	94	352	502	32	11
50	10	0	0	0	0	0	0	0	573	450
50	11	0	0	0	0	0	0	803	0	126
50	12	0	0	0	0	0	0	0	0	0
50	13	0	0	0	0	0	0	0	0	0
50	14	0	0	0	0	0	0	0	0	0
50	15	0	0	0	0	0	0	0	0	0
50	16	0	0	0	0	0	0	0	0	0
50	17	0	0	0	0	0	0	0	0	0
50	18	0	0	0	0	0	0	0	0	0
50	19	0	0	0	0	0	0	0	0	0
50	20	0	0	0	0	0	0	0	0	0

At this step the active coverage begins to take effect. The flow zero target enters the coverage of escort one.

At this time step, one of the forward active escorts has a significant detection probability in the convergence zone against the zero delay target. Against this same target, the starboard buoyfield has now accumulated considerable detection probability but the portfield is essentially as before because that field has been ferried during this time period.

TARGET EVALUATION AT TIME STEP 18 HOUR 00.04.30

GROUP NUMBER FOR MAP, (0=ENTIRE SCREEN) IS 0

TARGET	TIME DELAY	COP	XX = 10	20	30	40	50	60	70	80	90	100 nm
50	0	0.947	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	1	0.989	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000
50	2	0.938	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000
50	3	0.746	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000
50	4	0.972	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000
50	5	0.959	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
50	6	0.527	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000
50	7	0.559	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
50	8	0.504	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
50	9	0.101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	10	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	11	0.092	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

(Columns XX = 10 … 100 nm: PROBABILITY TARGET IS WITHIN XX nm OF PIM)

COP FOR FLOW OF TARGET 50 IS 0.416

AVERAGE COP FOR TARGETS IS 0.416

TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA Radius) .5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
50	0	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	2	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000
50	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE OVER THESE FLIGHTS		0.000	0.000	0.000	0.056	0.056	0.111	0.111	0.111	0.111	0.111
AVERAGE OVER ALL FLIGHTS		0.000	0.000	0.000	0.056	0.056	0.111	0.111	0.111	0.111	0.111

*** TIME STEP NUMBER 20 ***

CDP*10,000 BY SENSOR GROUP AND FLOW

GROUP		1	2	3	4	5	13	21	23	25
TARG	DELAY									
50	0	5826	5103	5081	4913	4745	6551	4469	3340	1671
50	1	5400	4215	5166	3244	4917	6015	9165	3244	3288
50	2	5044	1159	4913	0	4156	5408	9262	4240	5352
50	3	4701	0	2214	0	3264	4400	3529	4143	3704
50	4	1058	0	0	0	2951	3542	9231	2976	5427
50	5	0	0	0	0	2937	3402	9209	2757	2106
50	6	0	0	0	0	2040	3157	3246	2667	955
50	7	0	0	0	0	1758	2476	9120	2103	3004
50	8	0	0	0	0	1026	1897	7333	155	942
50	9	0	0	0	0	94	1780	502	82	1976
50	10	0	0	0	0	0	862	2008	573	1786
50	11	0	0	0	0	0	8	1291	0	126
50	12	0	0	0	0	0	0	0	1106	0
50	13	0	0	0	0	0	0	823	0	512
50	14	0	0	0	0	0	0	0	0	0
50	15	0	0	0	0	0	0	0	0	0
50	16	0	0	0	0	0	0	0	0	0
50	17	0	0	0	0	0	0	0	0	0
50	18	0	0	0	0	0	0	0	0	0
50	19	0	0	0	0	0	0	0	0	0
50	20	0	0	0	0	0	0	0	0	0

TARGET EVALUATION AT TIME STEP 20 HOUR 00.05.00

GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS 0

TARGET	TIME DELAY	COP
50	0	0.997
50	1	0.999
50	2	0.999
50	3	0.963
50	4	0.999
50	5	0.979
50	6	0.766
50	7	0.979
50	8	0.827
50	9	0.335
50	10	0.435
50	11	0.141
50	12	0.111
50	13	0.122
50	14	0.000
50	15	0.000
50	16	0.000
50	17	0.000
50	18	0.000
50	19	0.000

PROBABILITY TARGET IS WITHIN XX nm OF PIM

XX = 10	20	30	40	50	60	70	80	90	100 nm
0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

COP FOR FLOW OF TARGET 50 IS 0.484

AVERAGE COP FOR TARGETS IS 0.484

TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA Radius)									
		.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
50	0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	3	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	4	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE OVER THESE FLOWS		0.150	0.200	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
AVERAGE OVER ALL FLOWS		0.150	0.200	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250

At this time step, the zero delay target has arrived at the firing circle. Since this circle lies within the coverage area of the active escorts, there is a high probability of active detection by the time the target makes the attack. The delay targets up to the 4 unit delay are all subject to some detection by the active screen.

The MAP and MAPL options are functionally identical to CDP and CDPL, except that they display various maps as well as the computed results. For illustration of the results obtainable, a special target file was created. The LTAR is shown as follows.

```
TARGET PARAMETERS AT STEP   0  HOUR 00.00.00
     "R" = RELATIVE TO PIM = (   0.0,   0.0) PIM COURSE   0.0 PIM SPEED  20.0

         TARGET               COORDINATES    SPEED  S.D.  HEADING  S.D.  VEL CHG   2-SIGMA COV AXI       SOURCE LEVELS
                                nm      nm    kts   kts     deg    deg    #/hr      nm     nm    degs    1    2    3    4    5
 13 SAMPLE FOR MAPS          -100.0    70.0   50.0  3.0    90.0   10.0    0.0     20.1   12.5   -0.    155  120 -199 -199   10
                             -100.0R   70.0R  53.9R        111.8R                                      -199 -199 -199 -199 -199
TARGET PARAMETERS AT STEP   2  HOUR 00.00.30
     "R" = RELATIVE TO PIM = (   0.0,  10.0) PIM COURSE   0.0 PIM SPEED  20.0

         TARGET               COORDINATES    SPEED  S.D.  HEADING  S.D.  VEL CHG   2-SIGMA COV AXIS      SOURCE LEVELS
                                nm      nm    kts   kts     deg    deg    #/hr      nm     nm    degs    1    2    3    4    5
 13 SAMPLE FOR MAPS           -75.0    70.0   50.0  3.0    90.0   10.0    0.0     22.2   12.0    0.1   155  120 -199 -199   10
                              -75.0R   60.0R  53.9R        111.8R                                      -199 -199 -199 -199 -199
TARGET PARAMETERS AT STEP   4  HOUR 00.01.00
     "R" = RELATIVE TO PIM = (   0.0,  20.0) PIM COURSE   0.0 PIM SPEED  20.0

         TARGET               COORDINATES    SPEED  S.D.  HEADING  S.D.  VEL CHG   2-SIGMA COV AXIS      SOURCE LEVELS
                                nm      nm    kts   kts     deg    deg    #/hr      nm     nm    degs    1    2    3    4    5
 13 SAMPLE FOR MAPS           -50.0    70.0   50.0  3.0    90.0   10.0    0.0     13.9   15.6   90.0   155  120 -199 -199   10
                              -50.0R   50.0R  53.9R        111.8R                                      -199 -199 -199 -199 -199
TARGET PARAMETERS AT STEP   6  HOUR 00.01.30
     "R" = RELATIVE TO PIM = (   0.0,  30.0) PIM COURSE   0.0 PIM SPEED  20.0

         TARGET               COORDINATES    SPEED  S.D.  HEADING  S.D.  VEL CHG   2-SIGMA COV AXIS      SOURCE LEVELS
                                nm      nm    kts   kts     deg    deg    #/hr      nm     nm    degs    1    2    3    4    5
 13 SAMPLE FOR MAPS           -25.0    70.0   50.0  3.0    90.0   10.0    0.0     12.3    9.9   90.0   155  120 -199 -199   10
                              -25.0R   40.0R  53.9R        111.8R                                      -199 -199 -199 -199 -199
TARGET PARAMETERS AT STEP   8  HOUR 00.02.00
     "R" = RELATIVE TO PIM = (   0.0,  40.0) PIM COURSE   0.0 PIM SPEED  20.0

         TARGET               COORDINATES    SPEED  S.D.  HEADING  S.D.  VEL CHG   2-SIGMA COV AXIS      SOURCE LEVELS
                                nm      nm    kts   kts     deg    deg    #/hr      nm     nm    degs    1    2    3    4    5
 13 SAMPLE FOR MAPS            -0.0    70.0   50.0  3.0    90.0   10.0    0.0     20.0    7.5   90.0   155  120 -199 -199   10
                               -0.0R   30.0R  53.9R        111.8R                                      -199 -199 -199 -199 -199
```

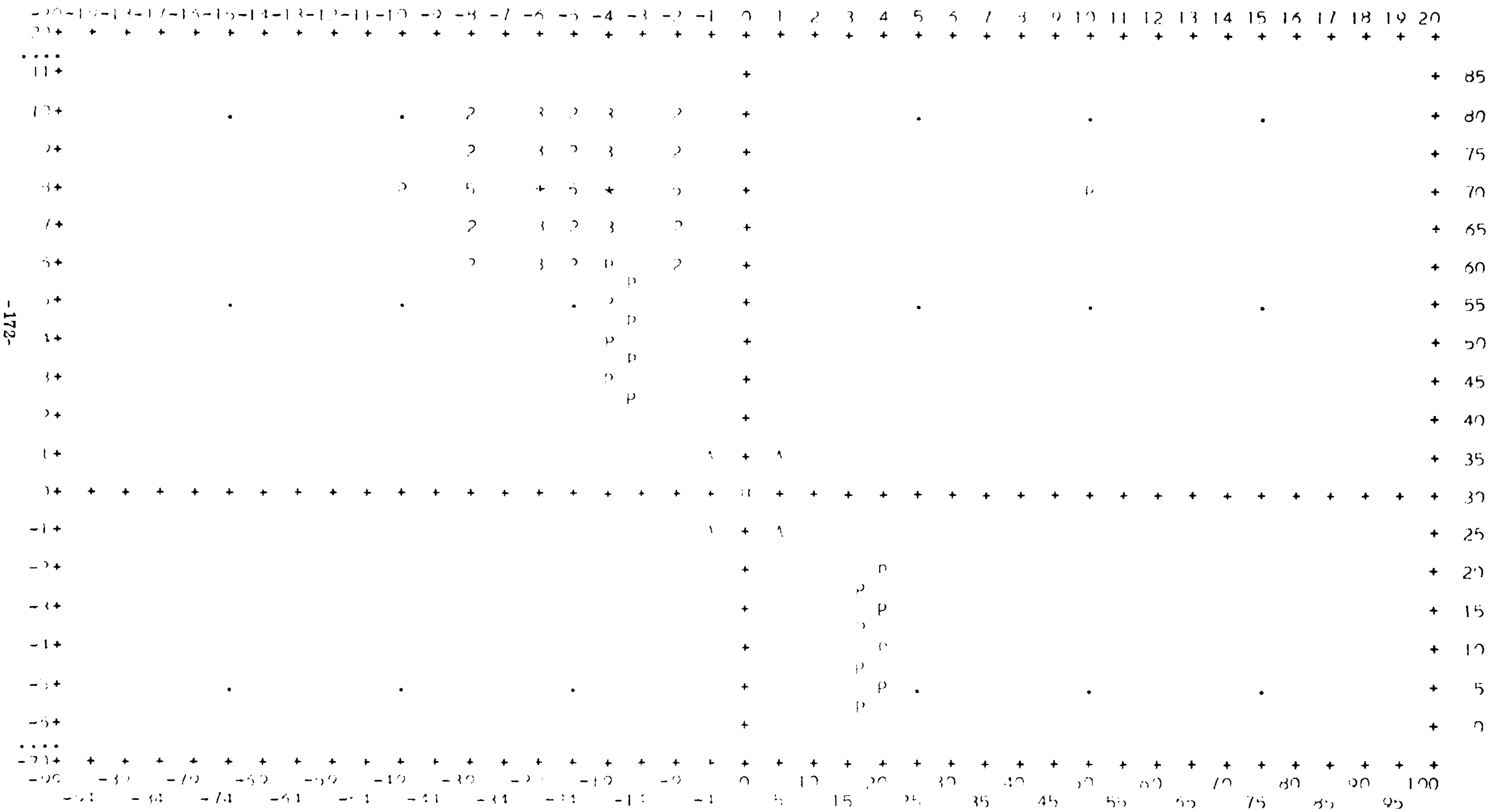
From this listing we see that the target moves from a north-south oriented spa centered at (-100,70) at time zero to an east-west oriented attack region at time step 8. The following responses produce maps at times 6,7 and 8. The <u>prior</u> map gives the target location at the time step in question, before search is applied. The <u>posterior</u> map is the conditional target location given that it has not been detected. The <u>information</u> map indicates how well the target has been localized at various points. In order to spread out the target positions, 49 samples of the target prior are taken.

```
SELECT MODE (HELP GIVES LIST): MAPL
PRINT PRIOR DISTRIBUTION (Y OR N): Y
PRINT POSTERIOR DISTRIBUTION (Y OR N): Y
ENTER GRID SPACING (nm): 5
ENTER START, STOP STEPS(1 - 21): 6,8
ENTER GROUP NUMBER (0=ENTIRE SCREEN): 0
ENTER STEPS OF FLOW (>=0): 0
ENTER TARGET FILE NO.  (1-99): 13
ENTER TARGET FILE NO.  (1-99): 0
ENTER NO. OF POINTS PER FLOW (1,9,25 OR 49): 49
```

```
*** TIME STEP NUMBER  6 ***

CDP*10,000 BY SENSOR GROUP AND TARGET
     GROUP        1     2     3     4     5    13    21    23    25
       TARG DELAY
        13    0    17     0   139     0  5723  1939  3703  7328   395


TARGET EVALUATION AT TIME STEP    6    HOUR 00.01.30

     GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS    0

       TARGET          TIME DELAY           CDP                      PROBABILITY TARGET IS WITHIN XX nm OF PIM
                                                            XX = 10    20    30    40    50    60    70    80    90   100 nm
        13                 0               0.948              0.000 0.000 0.000 0.011 0.412 0.999 1.000 1.000 1.000 1.000

          CDP FOR FUSED OF TARGET  13 IS  0.948


     AVERAGE CDP FOR TARGETS IS    0.948

MARKED ON MOL, MAR 03 1980 AT   20HR   10MIN   5.02SEC     D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y):    0.00  30.00
DISTANCE BETWEEN GRID POINTS:    5.00 NM

SYMBOL          DENSITY LIMITS/(N.M.)**2         PROBABILITY LIMITS
                0.000000    0.000245           0.000000    0.006122
  1             0.000245    0.000735           0.006122    0.018367
  2             0.000735    0.001224           0.018367    0.030612
  3             0.001224    0.001714           0.030612    0.042857
  4             0.001714    0.002204           0.042857    0.055102
  5             0.002204    0.002694           0.055102    0.067347
  6             0.002694    0.003184           0.067347    0.079592
  7             0.003184    0.003673           0.079592    0.091837
  8             0.003673    0.004163           0.091837    0.104082
  9             0.004163    0.004653           0.104082    0.116326
  *             0.004653    0.004898           0.116326    0.122449
```

PROBABILITY THAT THE TARGET IS NOT IN THIS MAP IS 0.000

PRIOR MAP



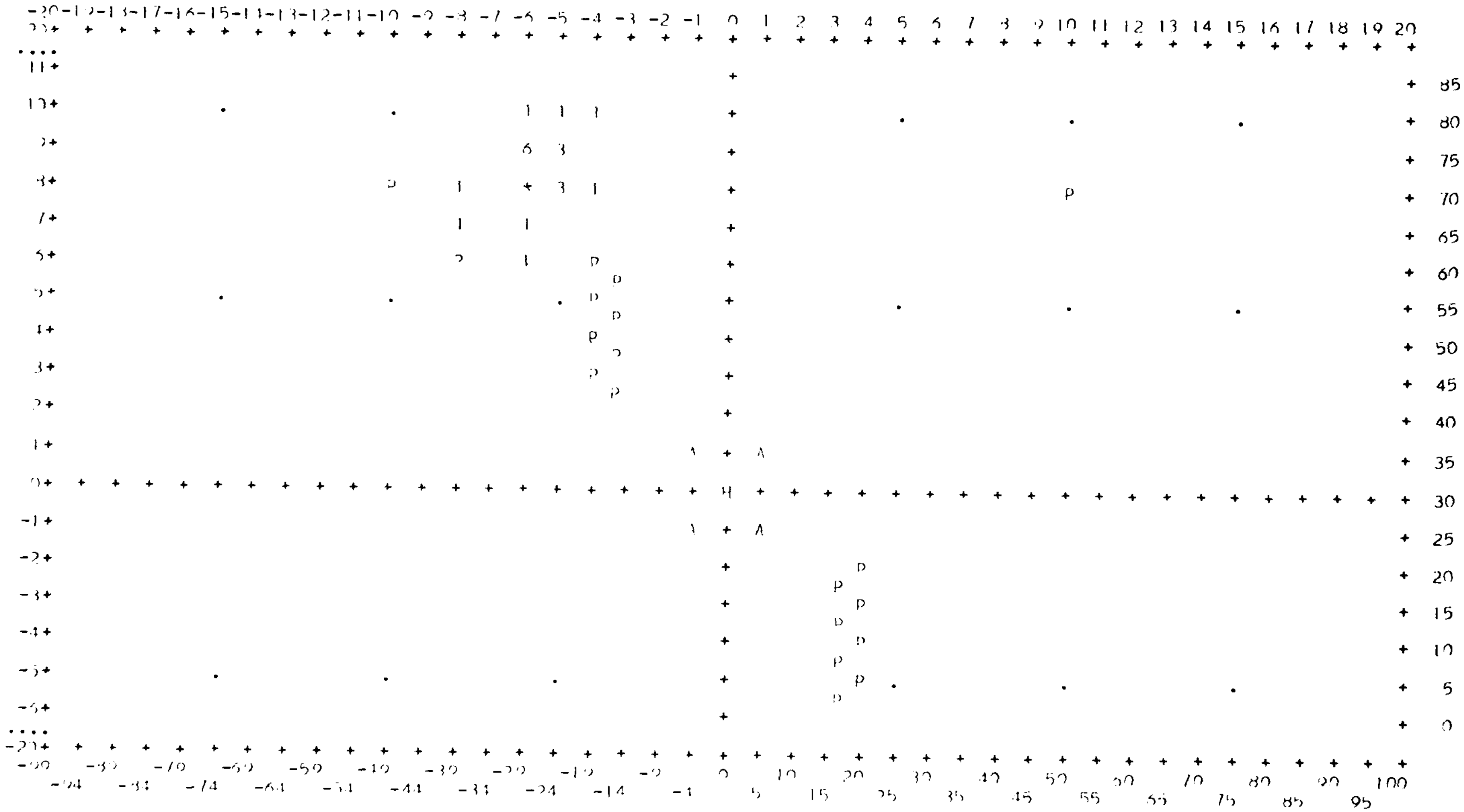
MARKED ON MON, MAR 03 1980 AT 20HR 10MIN 8.95SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y): 0.00 30.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000585	0.000000	0.014637
1	0.000585	0.001756	0.014637	0.043911
2	0.001756	0.002927	0.043911	0.073185
3	0.002927	0.004098	0.073185	0.102459
4	0.004098	0.005269	0.102459	0.131733
5	0.005269	0.006440	0.131733	0.161007
6	0.006440	0.007611	0.161007	0.190281
7	0.007611	0.008782	0.190281	0.219555
8	0.008782	0.009953	0.219555	0.248829
9	0.009953	0.011124	0.248829	0.278103
*	0.011124	0.011710	0.278103	0.292740

POSTERIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS 0.000

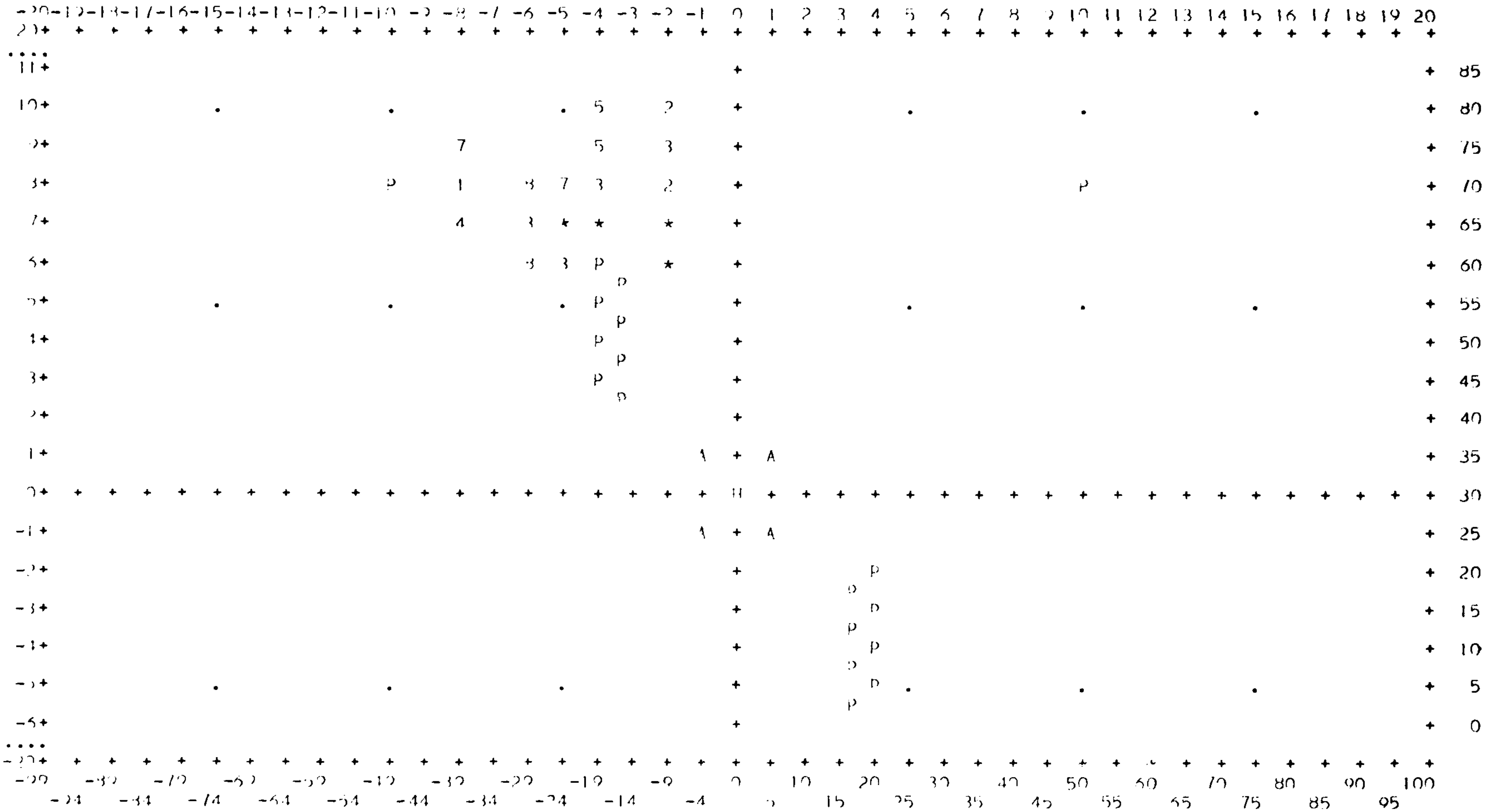
POSTERIOR MAP



TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA radius)									
		.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
13	0	0.122	0.245	0.347	0.490	0.612	0.653	0.653	0.714	0.735	0.735
AVERAGE OVER THESE FLOWS		0.122	0.245	0.347	0.490	0.612	0.653	0.653	0.714	0.735	0.735
AVERAGE OVER ALL FLOWS		0.122	0.245	0.347	0.490	0.612	0.653	0.653	0.714	0.735	0.735

MARKED ON MON, MAR 03 1980 AT 20HR 10MIN 13.05SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

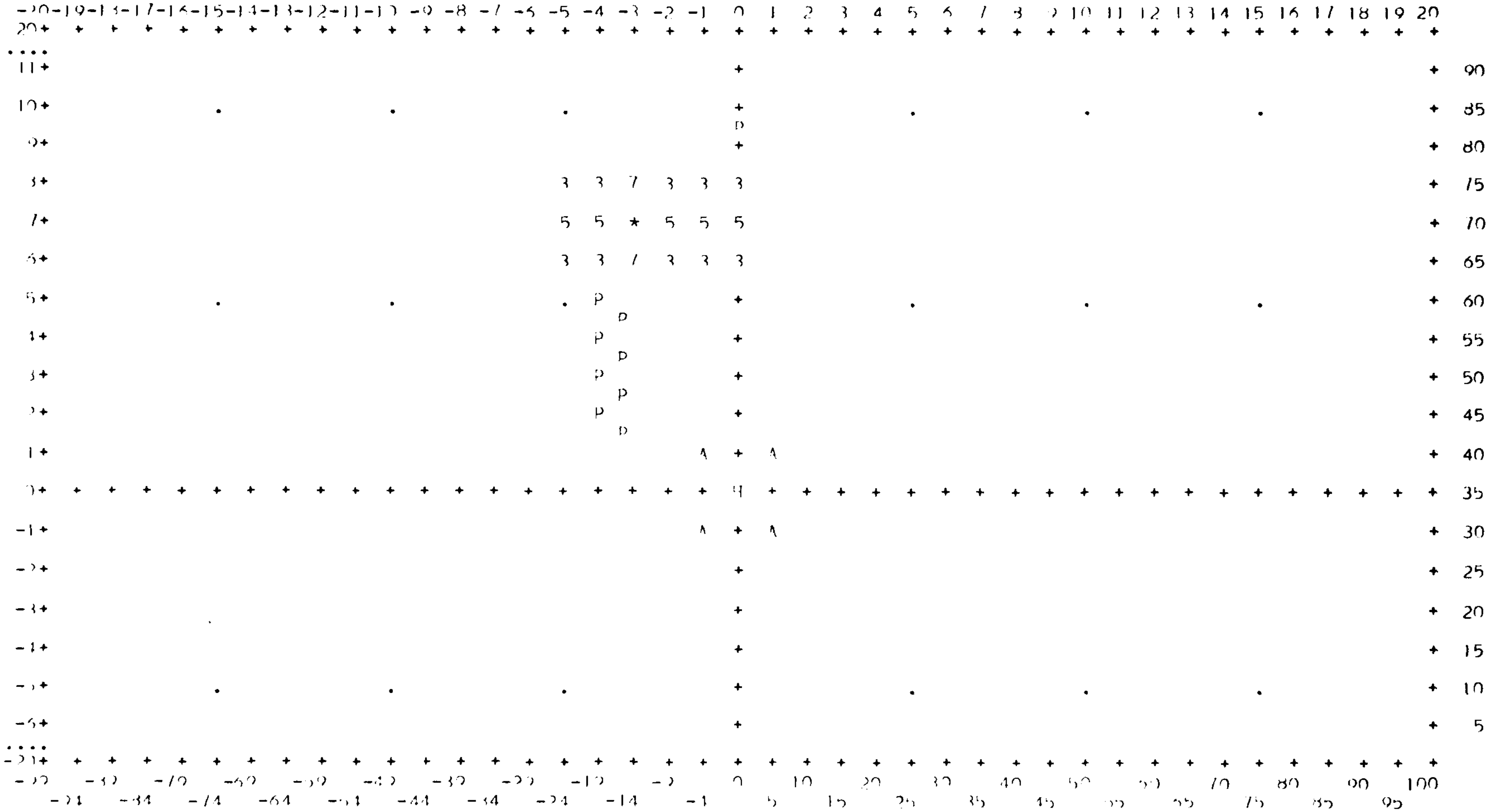
LOCALIZATION MAP



```
*** TIME STEP NUMBER  7 ***

CDP*10,000 BY SENSOR GROUP AND FLOW
      GROUP          1     2     3     4     5    13    21    23    25
        TARG DELAY
         13    0   741     0  1773     0  5114  1939  7224  7828   395


TARGET EVALUATION AT TIME STEP    7    HOUR 00.01.45

     GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS    0

      TARGET          TIME DELAY            CDP                       PROBABILITY TARGET IS WITHIN XX nm OF PIM
                                                           XX = 10    20    30    40    50    60    70    80    90    100 nm
       13                  0              0.981              0.000 0.000 0.001 0.470 1.000 1.000 1.000 1.000 1.000 1.000

          CDP FOR FLOW OF TARGET  13 IS  0.981

     AVERAGE CDP FOR TARGETS IS    0.981

MARKED ON MON, MAR 03 1980 AT   20HR   11MIN  42.03SEC     D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y):    0.00  35.00
DISTANCE BETWEEN GRID POINTS:    5.00 NM

SYMBOL          DENSITY LIMITS/(N.M.)**2          PROBABILITY LIMITS
                 0.000000    0.000245          0.000000    0.006122
  1              0.000245    0.000735          0.006122    0.018367
  2              0.000735    0.001224          0.018367    0.030612
  3              0.001224    0.001714          0.030612    0.042857
  4              0.001714    0.002204          0.042857    0.055102
  5              0.002204    0.002694          0.055102    0.067347
  6              0.002694    0.003184          0.067347    0.079592
  7              0.003184    0.003673          0.079592    0.091837
  8              0.003673    0.004163          0.091837    0.104082
  9              0.004163    0.004653          0.104082    0.116326
  +              0.004653    0.004898          0.116326    0.122449
```

PRIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS 0.000

PRIOR MAP

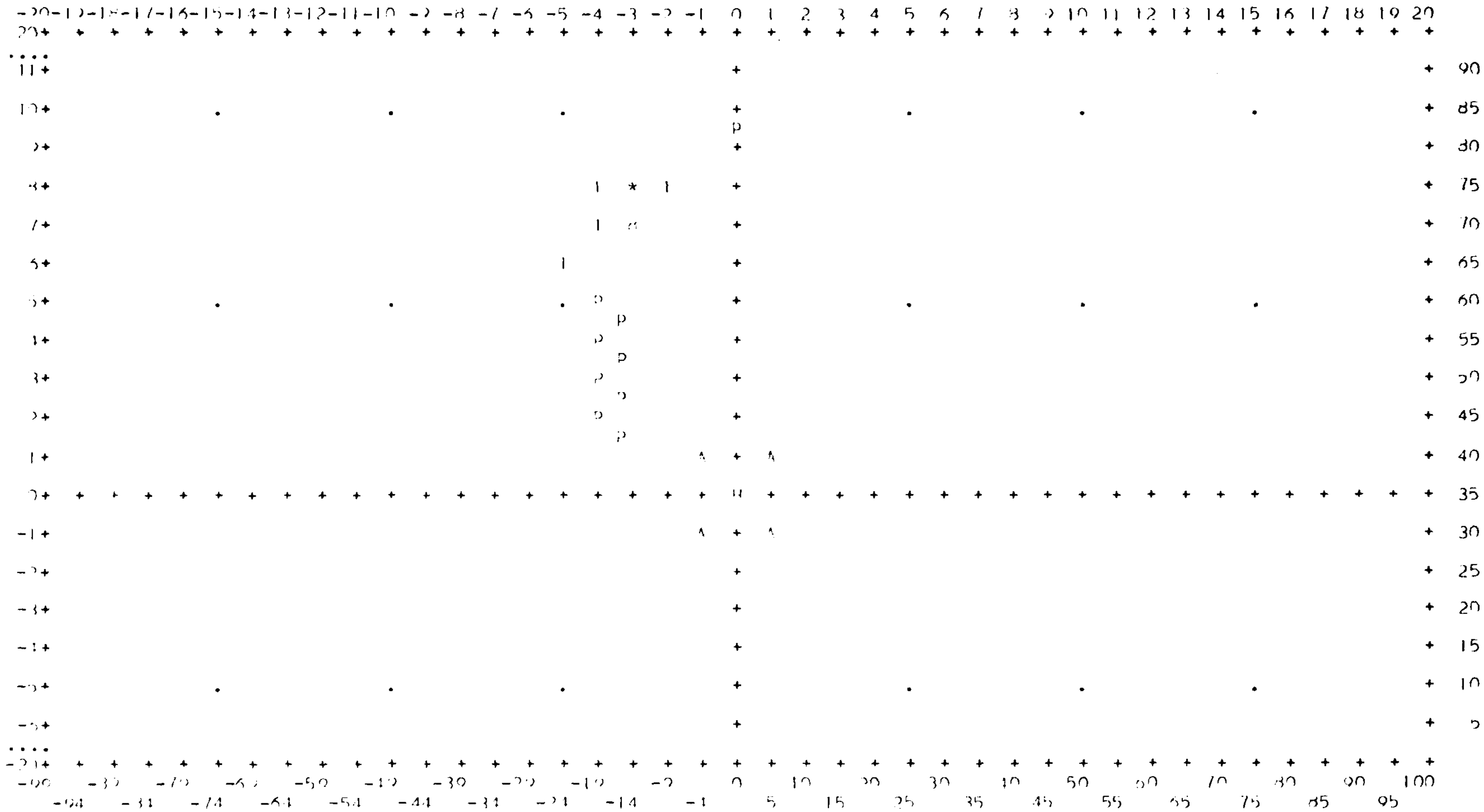


MARKED ON MON, MAR 03 1980 AT 20HR 11MIN 45.97SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y): 0.00 35.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000867	0.000000	0.021666
1	0.000867	0.002600	0.021666	0.064997
2	0.002600	0.004333	0.064997	0.108329
3	0.004333	0.006066	0.108329	0.151660
4	0.006066	0.007800	0.151660	0.194992
5	0.007800	0.009533	0.194992	0.238323
6	0.009533	0.011266	0.238323	0.281655
7	0.011266	0.012999	0.281655	0.324986
8	0.012999	0.014733	0.324986	0.368318
9	0.014733	0.016466	0.368318	0.411649
*	0.016456	0.017333	0.411649	0.433315

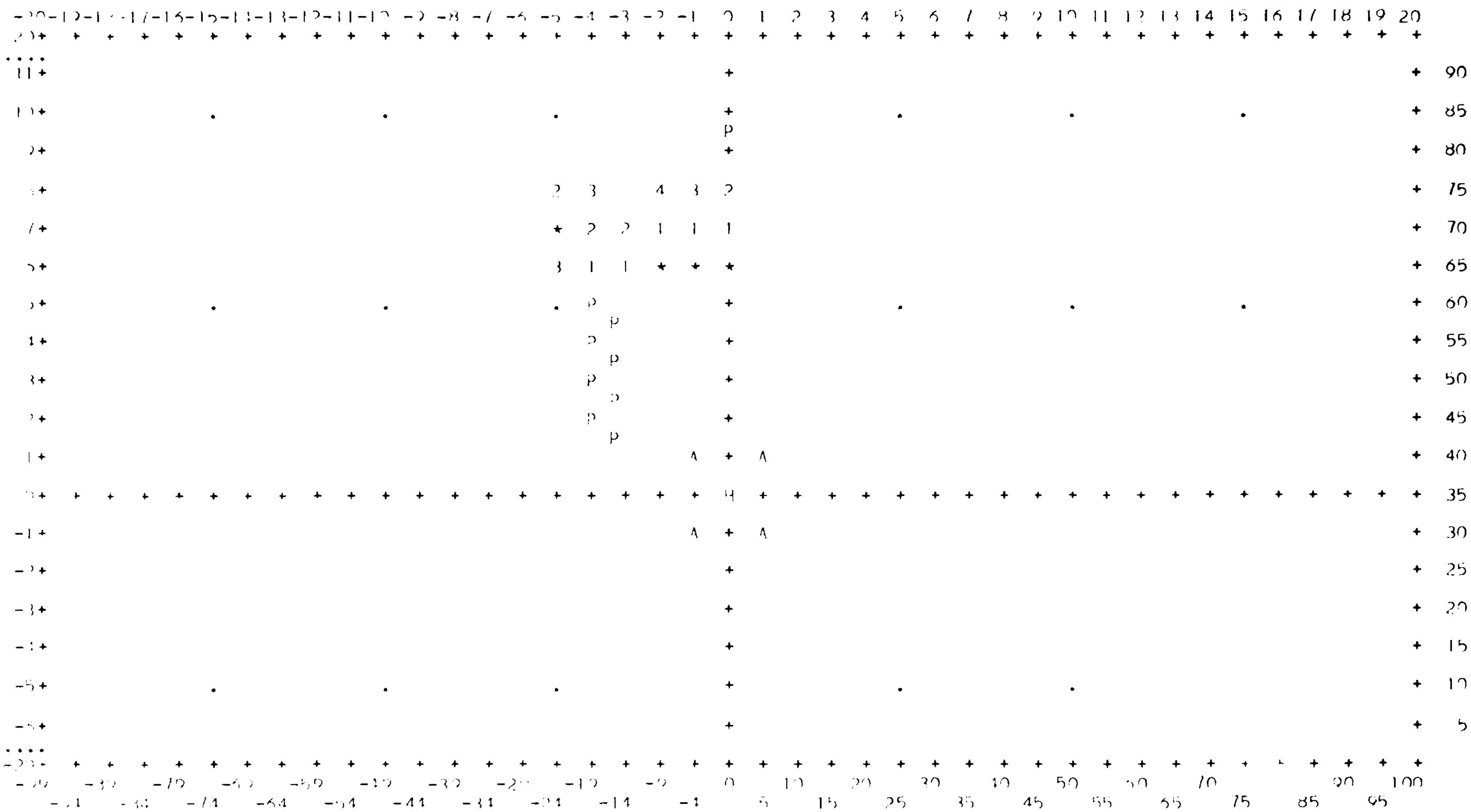
POSTERIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS 0.000



TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA radius)									
		.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
13	0	0.221	0.510	0.735	0.796	0.898	0.930	0.952	0.959	0.959	0.959
AVERAGE OVER THESE FLOWS		0.221	0.510	0.735	0.796	0.898	0.930	0.950	0.959	0.959	0.959
AVERAGE OVER ALL FLOWS		0.221	0.510	0.735	0.796	0.898	0.930	0.950	0.959	0.959	0.959

MARKED ... ON, MAR 03 1980 AT 20HR TIME 50.05SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

LOCALIZATION MAP



```
*** TIME STEP NUMBER 3 ***

COP*10,000 BY SENSOR GROUP AND FLOW
    GROUP           1      2      3      4      5     13     21     23     25
     TIME DELAY
      13      0 5023  123 4843  143 6400 1932 7294 8363 1425


SCREEN EVALUATION AT TIME STEP   3   HOUR 00.02.00

    GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS   0

    TARGET          TIME DELAY             COP                        PROBABILITY TARGET IS WITHIN XX nm OF PIM
                                                                 XX = 10    20    30    40    50    60    70    80    90   100 nm
     13                 0                 0.995                   0.000 0.000 0.115 1.000 1.000 1.000 1.000 1.000 1.000 1.000

        COP FOR FLOW OF TARGET  13 IS  0.995


    AVERAGE COP FOR TARGETS IS     0.995


[illegible] 1980 AT   20HR   13MIN  20.27SEC      D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3


[illegible] (X,Y):     0.00  40.00
[illegible]:     5.00 NM


ZONE          DENSITY LIMITS/(N.M.)**2          PROBABILITY LIMITS
               0.000000    0.000408          0.000000    0.010204
  1            0.000408    0.001224          0.010204    0.030612
  2            0.001224    0.002041          0.030612    0.051020
  3            0.002041    0.002857          0.051020    0.071429
  4            0.002857    0.003673          0.071429    0.091837
  5            0.003673    0.004490          0.091837    0.112245
  6            0.004490    0.005306          0.112245    0.132653
  7            0.005306    0.006122          0.132653    0.153061
  8            0.006122    0.006939          0.153061    0.173469
  9            0.006939    0.007755          0.173469    0.193877
  *            0.007755    0.008163          0.193877    0.204082
```

AD-A087 839 WAGNER (DANIEL H) ASSOCIATES PAOLI PA F/G 15/1
USER'S MANUAL FOR THE SCREEN PROGRAM.(U)
MAY 80 D C BOSSARD, K M SOMMAR N00014-76-C-0811

UNCLASSIFIED NL

3 OF 3
AD A
087839

END
DATE
FILMED
9-80
DTIC

PRIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS   0.000

PRIOR MAP

```
-20-19-18-17-16-15-14-13-12-11-10 -9 -8 -7 -6 -5 -4 -3 -2 -1  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
 20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
....
 11+                                                           +                                                           +  95
 10+              .              .              .              +              .              .              .              +  90
  9+                                                           +                                                           +  85
  8+                             P                             +                             P                             +  80
  7+                                                     1  2  1  2  1                                                     +  75
  6+                                                     5  *  5  *  5                                                     +  70
  5+              .              .              .        1  2  1  2  1        .              .              .              +  65
  4+                                             P           +                                                           +  60
                                                   P
  3+                                             P           +                                                           +  55
                                                   P
  2+                                             P           +                                                           +  50
                                                   P
  1+                                             P        A  +  A                                                        +  45
                                                   P
  0+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  4  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  40
 -1+                                                        A  +  A                                                        +  35
 -2+                                                           +                                                           +  30
 -3+                                                           +                                                           +  25
 -4+                                                           +                                                           +  20
 -5+              .              .              .              +              .              .              .              +  15
 -6+                                                           +                                                           +  10
....
-20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
-99   -89   -79   -69   -59   -49   -39   -29   -19    -9     0    10    20    30    40    50    60    70    80    90   100
   -94   -84   -74   -64   -54   -44   -34   -24   -14    -4     5    15    25    35    45    55    65    75    85    95
```

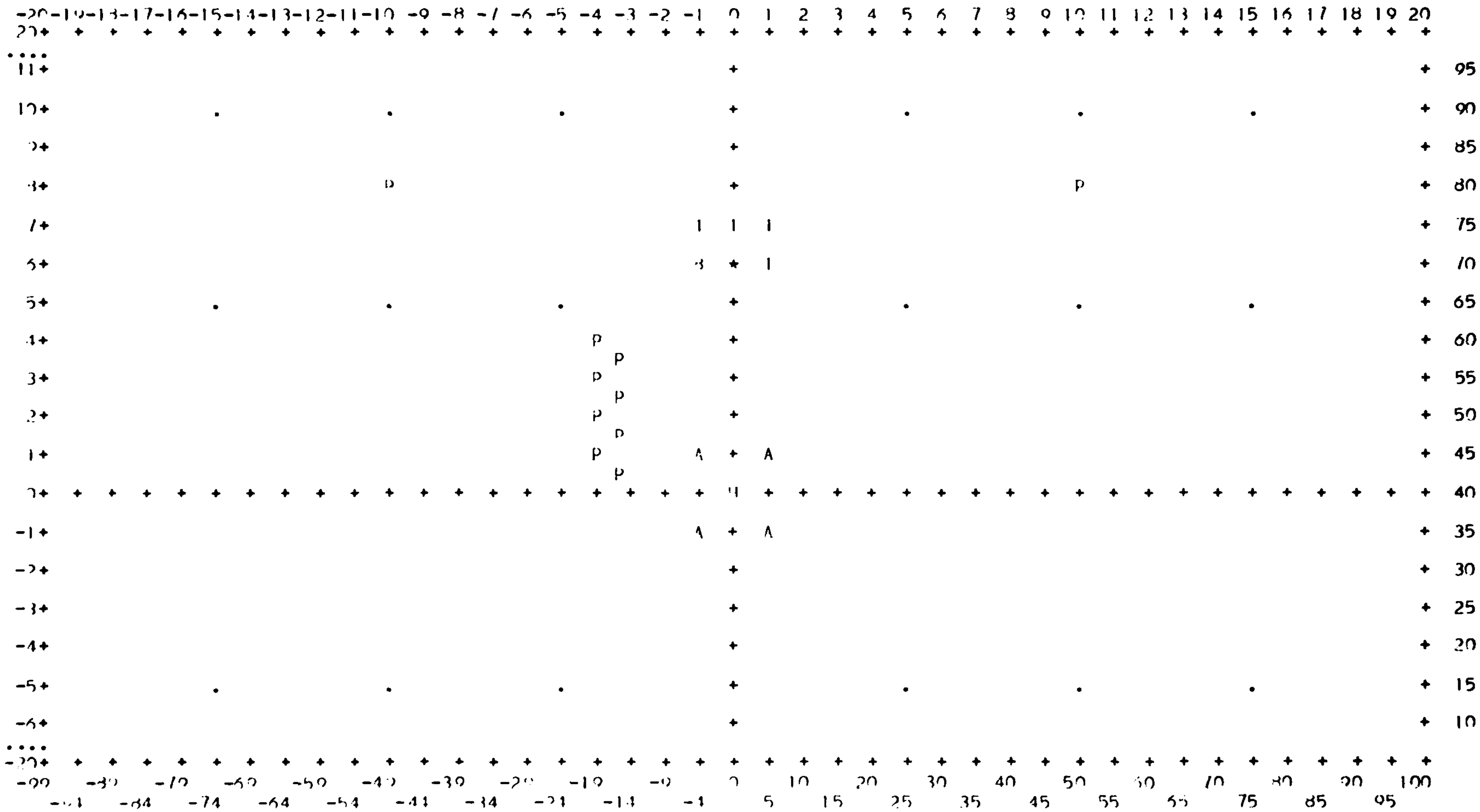
MARKED ON MON, MAR 03 1980 AT 20HR 13MIN 33.10SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y): 0.00 40.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000829	0.000000	0.020732
1	0.000829	0.002488	0.020732	0.062197
2	0.002488	0.004146	0.062197	0.103661
3	0.004146	0.005805	0.103661	0.145125
4	0.005805	0.007464	0.145125	0.186590
5	0.007464	0.009122	0.186590	0.228054
6	0.009122	0.010781	0.228054	0.269519
7	0.010781	0.012439	0.269519	0.310983
8	0.012439	0.014098	0.310983	0.352447
	0.014098	0.015756	0.352447	0.393912
	0.015756	0.016586	0.393912	0.414644

POSTERIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS 0.000

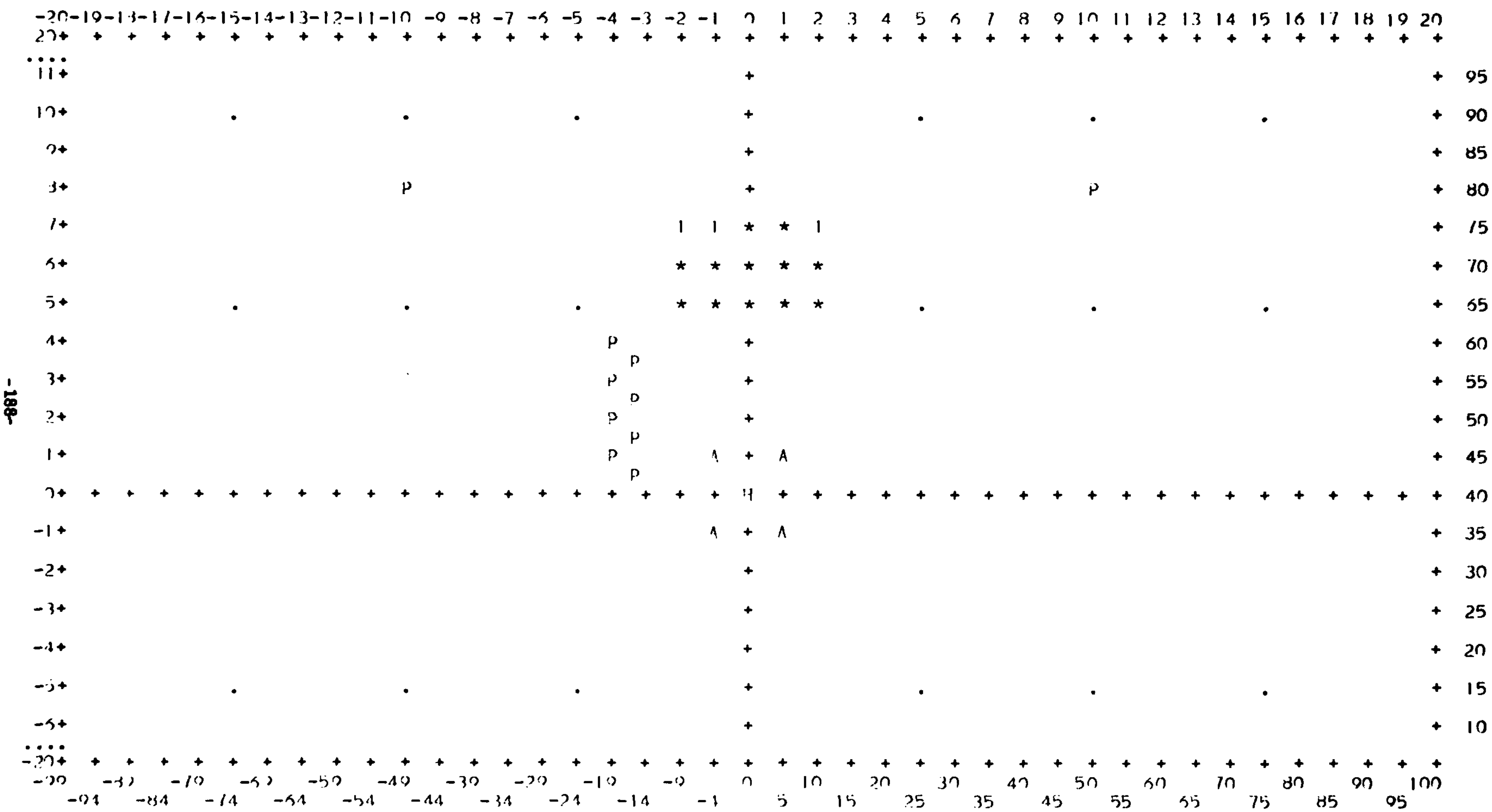
POSTERIOR MAP



TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA Radius)									
		.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
13	0	0.837	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AVERAGE OVER THESE FLOWS		0.837	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AVERAGE OVER ALL FLOWS		0.837	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

MARKED ON MON, MAR 03 1980 AT 20HR 13MIN 37.26SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

LOCALIZATION MAP



Finally, we will show the effect of target flow. The next is the same target as above, but with 8 steps of flow, evaluated at time steps 6 to 8 . Effectively, this means that the target arrival time is uniformly spaced over the eight time steps. Thus, the prior will be extended back all the way from the attack ellipse to the starting position. The results for this run are as follows.

```
SELECT MODE (HELP GIVES LIST):  MAPL
PRINT PRIOR DISTRIBUTION (Y OR N):  Y
PRINT POSTERIOR DISTRIBUTION (Y OR N):  Y
ENTER GRID SPACING (nm):  5
ENTER START, STOP STEPS (1-21):  6,8
ENTER GROUP NUMBER (0=ENTIRE SCREEN):  0
ENTER STEPS OF FLOW (>=0):  8
ENTER TARGET FILE NO.  (1-99):  13
ENTER TARGET FILE NO.  (1-99):  0
ENTER NO. OF POINTS PER FLOW (1,9,25, OR 49):  49
```

FIGURE VI-13

*** TIME STEP NUMBER 6 ***

CDP*10,000 BY SENSOR GROUP AND FLOW

TARG	DELAY	GROUP 1	2	3	4	5	13	21	23	25
13	0	17	0	109	0	5723	1939	3703	7328	395
13	1	0	0	0	0	4937	1438	1285	7301	282
13	2	0	0	0	0	3335	751	1094	6406	137
13	3	0	0	0	0	2706	156	327	6749	0
13	4	0	0	0	0	2011	5	267	4661	0
13	5	0	0	0	0	832	0	0	1397	0
13	6	0	0	0	0	0	0	0	0	0
13	7	0	0	0	0	0	0	0	0	0
13	8	0	0	0	0	0	0	0	0	0

TARGET EVALUATION AT TIME STEP 6 HOUR 00.01.30
GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS 0

PROBABILITY TARGET IS WITHIN XX nm OF PIM

TARGET	TIME DELAY	CDP	XX = 10	20	30	40	50	60	70	80	90	100 nm
13	0	0.948	0.000	0.000	0.000	0.011	0.412	0.990	1.000	1.000	1.000	1.000
13	1	0.912	0.000	0.000	0.000	0.023	0.136	0.559	0.801	1.000	1.000	1.000
13	2	0.789	0.000	0.000	0.000	0.000	0.018	0.044	0.161	0.255	1.000	1.000
13	3	0.732	0.000	0.000	0.000	0.000	0.000	0.000	0.055	0.686	0.837	0.924
13	4	0.576	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.054	0.120	0.350
13	5	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.115

CDP FOR FLOW OF TARGET 13 IS 0.711

AVERAGE CDP FOR TARGETS IS 0.711
MARKED ON MON, MAR 03 1980 AT 20HR 50MIN 30.45SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y): 0.00 30.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000048	0.000000	0.001190
1	0.000048	0.000143	0.001190	0.003571
2	0.000143	0.000238	0.003571	0.005952
3	0.000238	0.000333	0.005952	0.008333
4	0.000333	0.000429	0.008333	0.010714
5	0.000429	0.000524	0.010714	0.013095
6	0.000524	0.000619	0.013095	0.015476
7	0.000619	0.000714	0.015476	0.017857
8	0.000714	0.000810	0.017857	0.020238
9	0.000810	0.000905	0.020238	0.022619
+	0.000905	0.000952	0.022619	0.023810

PRIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS   0.024

```
                                      PRIOR MAP
  -20-19-18-17-16-15-14-13-12-11-10 -9 -8 -7 -6 -5 -4 -3 -2 -1  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
  20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
....
  17+  1  1  3  1  1                                          +                                                           + 115
  16+                                                         +                                                           + 110
  15+  1  3  4  3  3  1  1  1     .              .            +              .              .              .              + 105
  14+  1  3  4  3  4  3  3  4  1  1                           +                                                           + 100
  13+  1  1  3  1  1                                          +                                                           +  95
  12+  1  4  6  4  6  4  6  6  4  3  3     1                  +                                                           +  90
  11+  1  3  4  3  4  3  4  4  4  4  4  3  3  1  1            +                                                           +  85
  10+     1  1  1  3  3  4  4  4  4  4  4  3  4  3  3     1   +              .              .              .              +  80
   9+  1  1  3  1  4  3  6  6  9  9  9  7  6  6  4  3     1   +                                                           +  75
   8+     1  1  1  1  1  3  1  3  2  4  7  3  +  6  9     4   +                             P                             +  70
   7+              1  1  3  3  4  4  4  4  3  4  3  3     1   +                                                           +  65
   6+                             1  1  4  1  4  3  P     1   +                                                           +  60
                                                       P
   5+              .              .              .  P         +              .              .              .              +  55
                                                       P
   4+                                                P        +                                                           +  50
                                                       P
   3+                                                P        +                                                           +  45
                                                       P
   2+                                                         +                                                           +  40
   1+                                                      A  +  A                                                        +  35
   0+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  H  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  30
  -1+                                                      A  +  A                                                        +  25
  -2+                                                         +           P                                               +  20
                                                                       P
  -3+                                                         +           P                                               +  15
                                                                       P
  -4+                                                         +           P                                               +  10
....
 -20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
     -94   -84   -74   -64   -54   -44   -34   -24   -14    -4     5    15    25    35    45    55    65    75    85    95
```

MARKED ON MON, MAR 03 1980 AT 20HR 50MIN 34.33SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3
MAP CENTER COORD (X,Y): 0.00 30.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000084	0.000000	0.002094
1	0.000084	0.000251	0.002094	0.006282
2	0.000251	0.000419	0.006282	0.010470
3	0.000419	0.000586	0.010470	0.014658
4	0.000586	0.000754	0.014658	0.018845
5	0.000754	0.000921	0.018845	0.023033
6	0.000921	0.001089	0.023033	0.027221
7	0.001089	0.001256	0.027221	0.031409
8	0.001256	0.001424	0.031409	0.035597
9	0.001424	0.001591	0.035597	0.039785
+	0.001591	0.001675	0.039785	0.041879

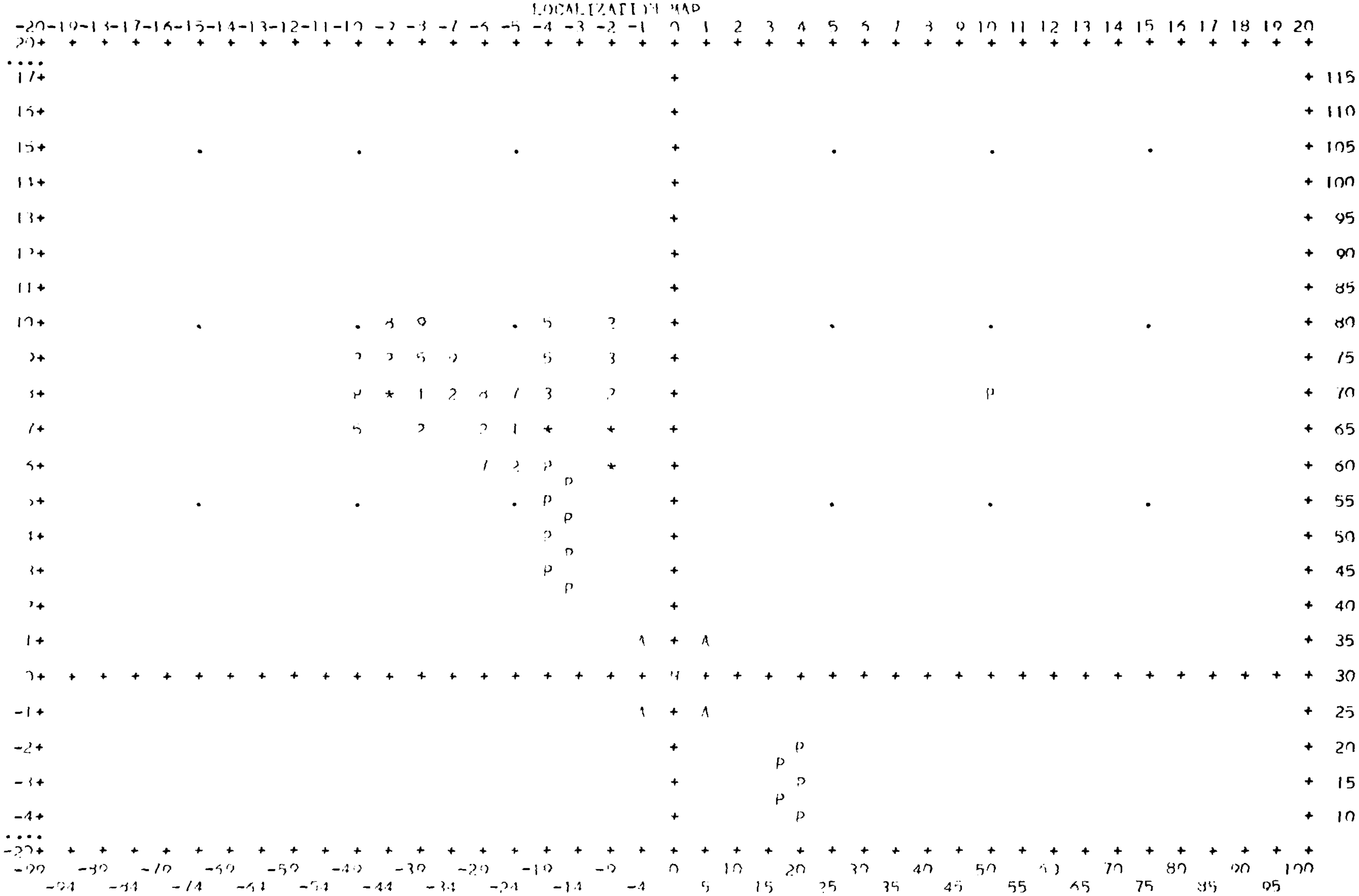
POSTERIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS   0.061

```
                                                      POSTERIOR MAP
 -20-19-18-17-16-15-14-13-12-11-10 -9 -8 -7 -6 -5 -4 -3 -2 -1  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
 20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
....
 17+  2  2  4  2  2                                            +                                                           + 115
 16+                                                           +                                                           + 110
 15+  2  4  7  5  5  2  2  2     .              .              +              .              .              .              + 105
 14+  2  3  8  5  7  3  1  1                                   +                                                           + 100
 13+  2  3  5  3  1                                            +                                                           +  95
 12+  2  7  *  6  2  1  1  1  1  3  3     1                    +                                                           +  90
 11+  3  5  8  1  1     1  2  5  4  3                          +                                                           +  85
 10+     2  1     .     1  3  4  2              .              +              .              .              .              +  80
  9+  3  3  4     1     5  5  4  1  1     1  2  2              +                                                           +  75
  8+     2              2  1  1  2           2  1              +                             P                             +  70
  7+                    3  2  1           1                    +                                                           +  65
  6+                                 2           P             +                                                           +  60
                                                    p
  5+              .              .              .  P           +              .              .              .              +  55
                                                    p
  4+                                                 P         +                                                           +  50
                                                    p
  3+                                                 P         +                                                           +  45
                                                    p
  2+                                                           +                                                           +  40
  1+                                                        Λ  +  Λ                                                        +  35
  0+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  H  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  30
 -1+                                                        Λ  +  Λ                                                        +  25
 -2+                                                           +           P                                               +  20
                                                                        p
 -3+                                                           +           p                                               +  15
                                                                        P
 -4+                                                           +           P                                               +  10
....
-20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 -90   -80   -70   -60   -50   -40   -30   -20   -10    -0     0    10    20    30    40    50    60    70    80    90   100
```

TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA Radius)									
		.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
13	0	0.122	0.245	0.347	0.490	0.612	0.653	0.653	0.714	0.735	0.735
13	1	0.143	0.265	0.306	0.347	0.367	0.429	0.429	0.449	0.510	0.551
13	2	0.102	0.163	0.184	0.204	0.224	0.286	0.286	0.306	0.306	0.347
13	3	0.020	0.020	0.020	0.020	0.020	0.061	0.082	0.082	0.082	0.082
13	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE OVER THESE FLOWS		0.065	0.116	0.143	0.177	0.204	0.238	0.241	0.259	0.272	0.286
AVERAGE OVER ALL FLOWS		0.065	0.116	0.143	0.177	0.204	0.238	0.241	0.259	0.272	0.286

MARKED ON MON, MAR 03 1980 AT 20HR 50MIN 38.64SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

LOCALIZATION MAP



*** TIME STEP NUMBER 7 ***

DP*10,000 BY SENSOR GROUP AND FLOW

GROUP		1	2	3	4	5	13	21	23	25
TARG	DELAY									
13	0	741	0	1774	0	6114	1939	7224	7828	395
13	1	61	0	427	0	5733	1438	6593	7801	282
13	2	0	0	25	0	4179	751	3508	6406	137
13	3	0	0	1	0	3251	156	1275	6749	0
13	4	0	0	0	0	2516	5	1959	4661	0
13	5	0	0	0	0	1317	0	317	1397	0
13	6	0	0	0	0	459	0	267	0	0
13	7	0	0	0	0	0	0	0	0	0
13	8	0	0	0	0	0	0	0	0	0

TARGET EVALUATION AT TIME STEP 7 HOUR 00.01.45
GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS 0

PROBABILITY TARGET IS WITHIN XX nm OF PIM

TARGET	TIME DELAY	CDP	XX = 10	20	30	40	50	60	70	80	90	100 nm
13	0	0.981	0.000	0.000	0.001	0.470	1.000	1.000	1.000	1.000	1.000	1.000
13	1	0.966	0.000	0.000	0.000	0.111	0.443	1.000	1.000	1.000	1.000	1.000
13	2	0.849	0.000	0.000	0.000	0.003	0.022	0.419	0.994	1.000	1.000	1.000
13	3	0.808	0.000	0.000	0.000	0.000	0.003	0.190	0.739	0.880	1.000	1.000
13	4	0.612	0.000	0.000	0.000	0.000	0.000	0.020	0.087	0.137	0.678	0.966
13	5	0.399	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.006	0.236	0.695
13	6	0.274	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.210

CDP FOR FLOW OF TARGET 13 IS 0.656

AVERAGE CDP FOR TARGETS IS 0.656
MARKED ON MON, MAR 03 1980 AT 21HR 0MIN 24.34SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3
MAP CENTER COORD (X,Y): 0.00 35.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000041	0.000000	0.001020
1	0.000041	0.000122	0.001020	0.003061
2	0.000122	0.000204	0.003061	0.005102
3	0.000204	0.000286	0.005102	0.007143
4	0.000286	0.000367	0.007143	0.009184
5	0.000367	0.000449	0.009184	0.011224
6	0.000449	0.000531	0.011224	0.013265
7	0.000531	0.000612	0.013265	0.015306
8	0.000612	0.000694	0.015306	0.017347
9	0.000694	0.000776	0.017347	0.019388
*	0.000776	0.000816	0.019388	0.020493

PRIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS   0.020

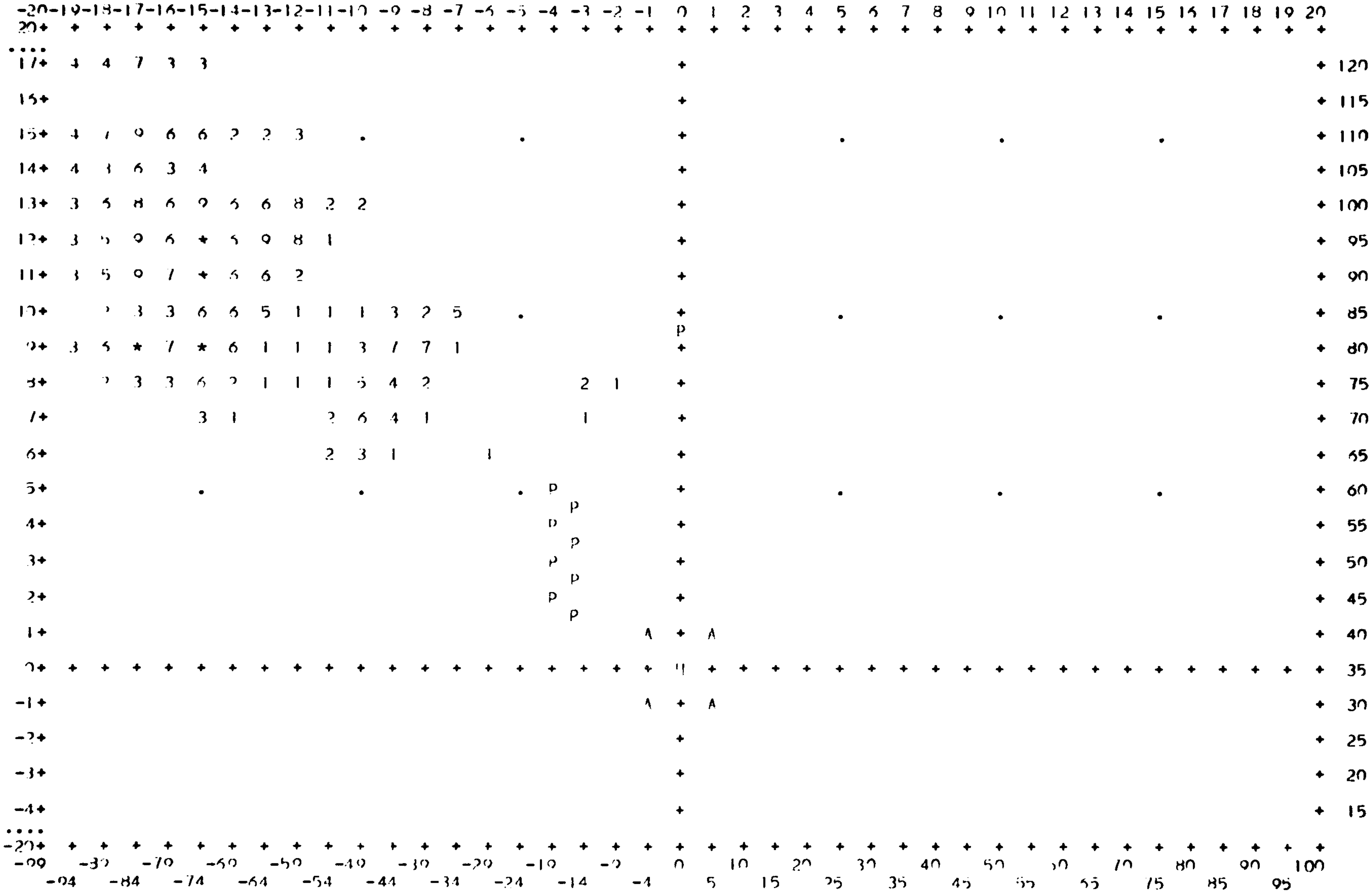
```
                                                          PRIOR MAP
    -20-19-18-17-16-15-14-13-12-11-10 -9 -8 -7 -6 -5 -4 -3 -2 -1  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
 20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
....
 17+     1  1  3  1  1                                         +                                                             + 120

 15+                                                           +                                                             + 115

 15+     1  3  4  3  3  1  1  1     .              .           +              .              .              .                + 110

 14+     1  1  3  1  1                                         +                                                             + 105

 13+     1  3  4  3  4  3  3  4  1  1                          +                                                             + 100

 12+     1  3  4  3  4  3  4  4  4  3  3     1                 +                                                             +  95

 11+     1  3  4  3  4  3  3  4  1  1                          +                                                             +  90

 10+        1  1  1  3  3  6  4  7  6  7  3  4  1  1           +              .              .              .                +  85
                                                               P
  9+     1  3  4  3  4  3  4  4  4  6  6  7  4  6  4  3     1  +                                                             +  80

  8+        1  1  1  3  3  4  4  4  4  4  6  3  7  7  9  6  6  3  3                                                          +  75

  7+                 1  1  3  3  4  6  6  9  4  9  *  *  9  7  4  4                                                          +  70

  6+                       1     3  3  4  6  3  7  7  9  6  6  3  3                                                          +  65

  5+                 .              .              .  P        +              .              .              .                +  60
                                                         P
  4+                                                  P        +                                                             +  55
                                                         P
  3+                                                  P        +                                                             +  50
                                                         P
  2+                                                  P        +                                                             +  45
                                                         P
  1+                                                        A  +  A                                                          +  40

  0+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  H  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  35

 -1+                                                        A  +  A                                                          +  30

 -2+                                                           +                                                             +  25

 -3+                                                           +                                                             +  20

 -4+                                                           +                                                             +  15
....
-20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 -90    -80    -70    -60    -50    -40    -30    -20    -10     -0      0     10     20     30     40     50     60     70     80     90    100
```

MARKED ON MON, MAR 03 1980 AT 21HR 0MIN 28.21SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y): 0.00 35.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000046	0.000000	0.001157
1	0.000046	0.000139	0.001157	0.003470
2	0.000139	0.000231	0.003470	0.005784
3	0.000231	0.000324	0.005784	0.008097
4	0.000324	0.000416	0.008097	0.010411
5	0.000416	0.000509	0.010411	0.012724
6	0.000509	0.000602	0.012724	0.015038
7	0.000602	0.000694	0.015038	0.017351
8	0.000694	0.000787	0.017351	0.019665
9	0.000787	0.000879	0.019665	0.021978
*	0.000879	0.000925	0.021978	0.023135

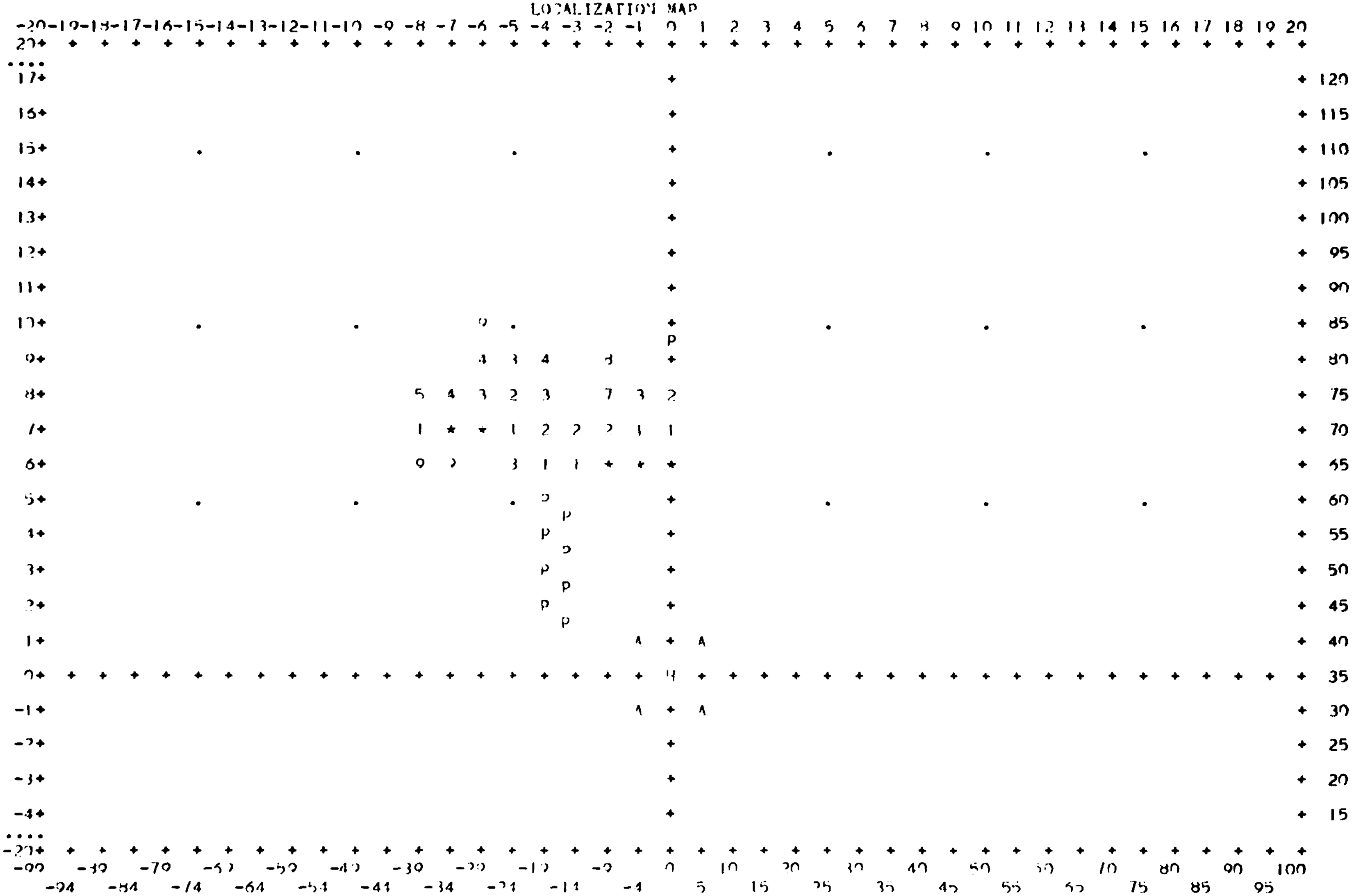
POSTERIOR MAP



TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA Radius)									
		.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
13	0	0.224	0.510	0.735	0.796	0.898	0.939	0.959	0.959	0.959	0.959
13	1	0.224	0.347	0.571	0.673	0.796	0.796	0.837	0.857	0.878	0.898
13	2	0.143	0.163	0.265	0.347	0.388	0.408	0.408	0.429	0.449	0.490
13	3	0.020	0.020	0.020	0.020	0.020	0.061	0.082	0.082	0.082	0.082
13	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE OVER THESE FLOWS		0.087	0.149	0.227	0.262	0.300	0.315	0.327	0.332	0.338	0.347
AVERAGE OVER ALL FLOWS		0.087	0.149	0.227	0.262	0.300	0.315	0.327	0.332	0.338	0.347

MARKED ON MON, MAR 03 1980 AT 21HR 0MIN 32.53SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

LOCALIZATION MAP



*** TIME STEP NUMBER 8 ***

CDP*10,000 BY SENSOR GROUP AND FLOW

GROUP		1	2	3	4	5	13	21	23	25
TARG	DELAY									
13	0	3093	123	4343	143	5409	1939	7294	8363	1428
13	1	1399	48	2830	225	6169	1438	6533	8700	1210
13	2	152	0	739	25	5300	751	3508	7541	404
13	3	0	0	50	0	4031	156	1275	7707	299
13	4	0	0	0	0	3956	5	1069	6463	138
13	5	0	0	0	0	2078	0	317	6676	0
13	6	0	0	0	0	1037	0	267	4811	0
13	7	0	0	0	0	496	0	0	1897	0
13	8	0	0	0	0	0	0	0	0	0

TARGET EVALUATION AT TIME STEP 8 HOUR 00.02.00
GROUP NUMBER FOR MAPS (0=ENTIRE SCREEN) IS 0

PROBABILITY TARGET IS WITHIN XX nm OF PIM

TARGET	TIME DELAY	CDP	XX = 10	20	30	40	50	60	70	80	90	100 nm
13	0	0.995	0.000	0.000	0.115	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1	0.984	0.000	0.000	0.024	0.307	1.000	1.000	1.000	1.000	1.000	1.000
13	2	0.917	0.000	0.000	0.000	0.031	0.860	1.000	1.000	1.000	1.000	1.000
13	3	0.896	0.000	0.000	0.000	0.004	0.441	0.845	0.927	1.000	1.000	1.000
13	4	0.775	0.000	0.000	0.000	0.000	0.021	0.065	0.343	0.978	1.000	1.000
13	5	0.743	0.000	0.000	0.000	0.000	0.000	0.005	0.17[illegible]	0.778	0.874	0.929
13	6	0.547	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.088	0.134	0.414
13	7	0.239	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.116

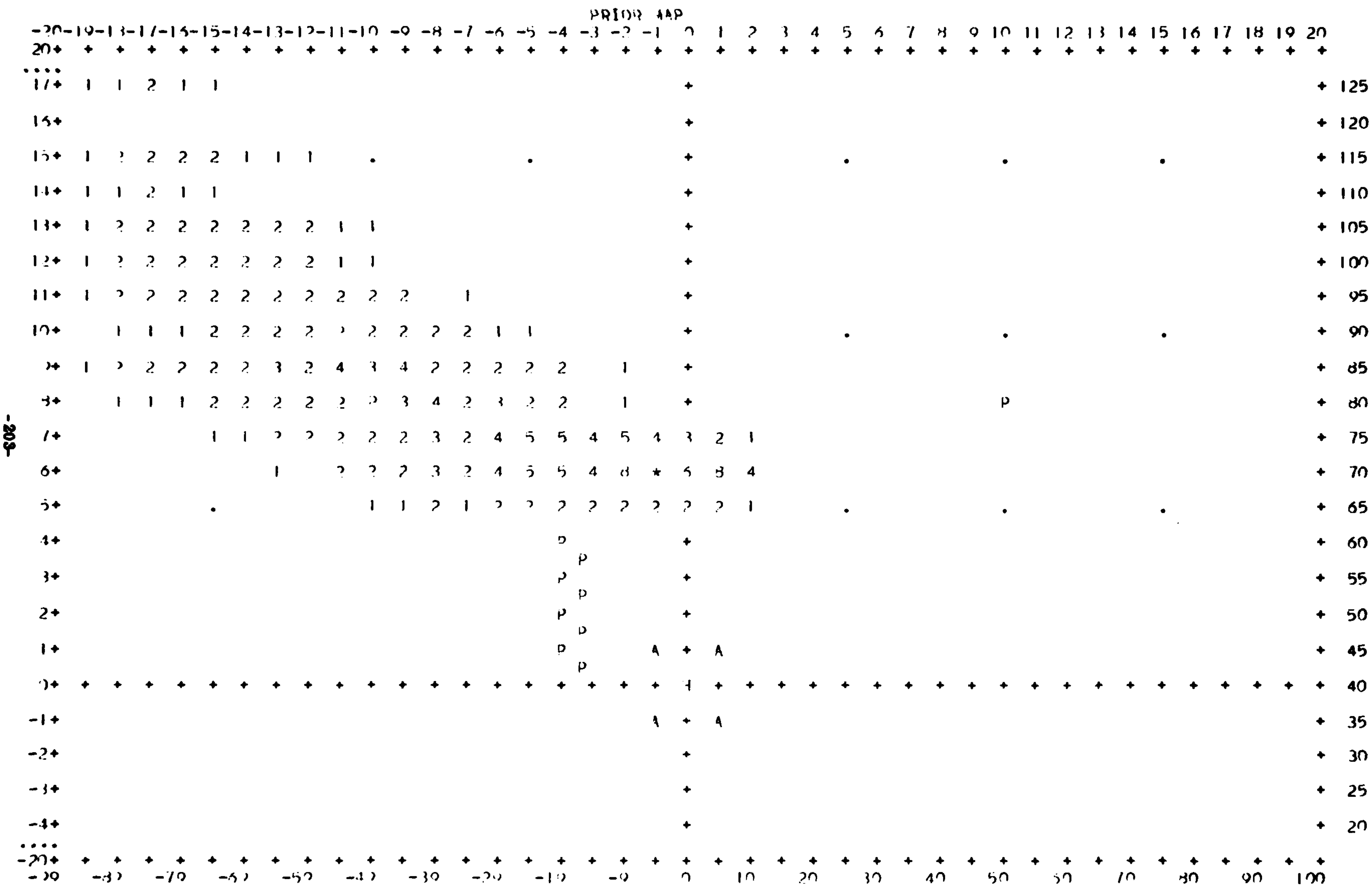
CDP FOR FLOW OF TARGET 13 IS 0.763

AVERAGE CDP FOR TARGETS IS 0.763

MARKED ON MON, MAR 03 1980 AT 21HR 11MIN 59.80SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3
MAP CENTER COORD (X,Y): 0.00 40.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000066	0.000000	0.001658
1	0.000066	0.000199	0.001658	0.004974
2	0.000199	0.000332	0.004974	0.008291
3	0.000332	0.000464	0.008291	0.011607
4	0.000464	0.000597	0.011607	0.014923
5	0.000597	0.000730	0.014923	0.018240
6	0.000730	0.000862	0.018240	0.021556
7	0.000862	0.000995	0.021556	0.024872
8	0.000995	0.001128	0.024872	0.028189
9	0.001128	0.001260	0.028189	0.031505
+	0.001260	0.001327	0.031505	0.033163

PRIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS 0.018



MARKED ON MON, MAR 03 1980 AT 21HR 12MIN 3.72SEC D.H. WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

MAP CENTER COORD (X,Y): 0.00 40.00
DISTANCE BETWEEN GRID POINTS: 5.00 NM

SYMBOL	DENSITY LIMITS/(N.M.)**2		PROBABILITY LIMITS	
	0.000000	0.000060	0.000000	0.001488
1	0.000060	0.000179	0.001488	0.004465
2	0.000179	0.000298	0.004465	0.007441
3	0.000298	0.000417	0.007441	0.010418
4	0.000417	0.000536	0.010418	0.013395
5	0.000536	0.000655	0.013395	0.016371
6	0.000655	0.000774	0.016371	0.019348
7	0.000774	0.000893	0.019348	0.022324
8	0.000893	0.001012	0.022324	0.025301
9	0.001012	0.001131	0.025301	0.028277
*	0.001131	0.001191	0.028277	0.029766

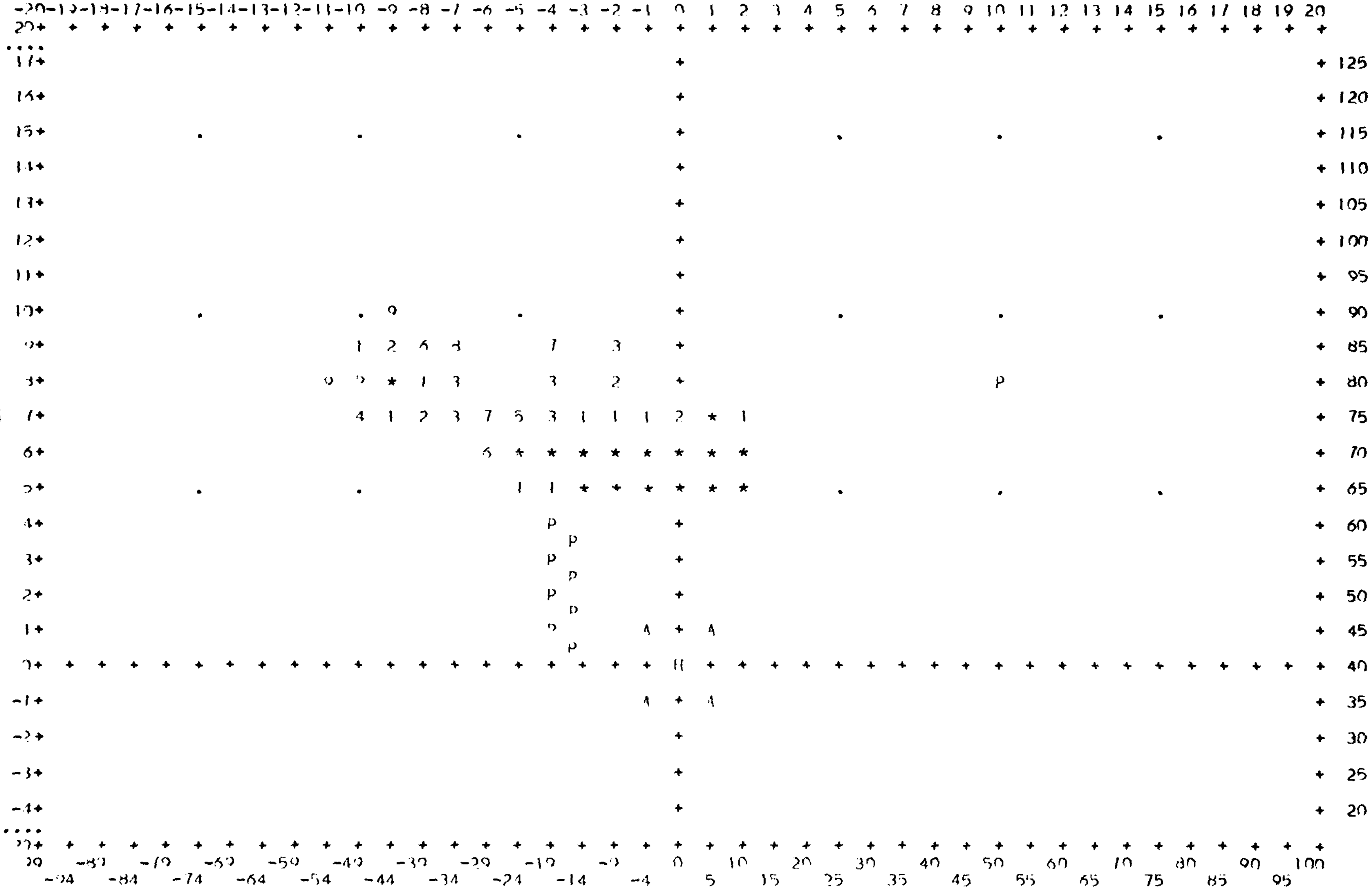
POSTERIOR PROBABILITY THAT THE TARGET IS NOT ON THIS MAP IS   0.061

```
                                                  POSTERIOR MAP
 -20-19-18-17-16-15-14-13-12-11-10 -9 -8 -7 -6 -5 -4 -3 -2 -1  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
 20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 ....
 17+  3  3  5  3  3                                            +                                                           + 125
 16+                                                           +                                                           + 120
 15+  3  5  9  7  6  3  3  3     .              .              +              .              .              .              + 115
 14+  3  3  7  3  3                                            +                                                           + 110
 13+  3  6  *  7  8  2  1  1                                   +                                                           + 105
 12+  3  5  *  6  2  1  1  1  1  2                             +                                                           + 100
 11+  3  5  *  2  1  1  1  3  4  4  4     2                    +                                                           +  95
 10+     3  2     1  1  1  7  5  4  2           .              +              .              .              .              +  90
  9+  3  7  6  1  1  1  5  6  6  1  1     1  1  3              +                                                           +  85
  8+     3  1     1  1  5  6  2  P        1  4  3              +                             P                             +  80
  7+                    4  3  1  1     1     3  3              +                                                           +  75
  6+                    2     1     1  4  2  2                 +                                                           +  70
  5+             .              .     3     1  .              +              .              .              .              +  65
  4+                                              P           +                                                           +  60
                                                     P
  3+                                              P           +                                                           +  55
                                                     P
  2+                                              P           +                                                           +  50
                                                     P
  1+                                              P        A  +  A                                                        +  45
                                                     P
  0+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  H  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  40
 -1+                                                        A  +  A                                                        +  35
 -2+                                                           +                                                           +  30
 -3+                                                           +                                                           +  25
 -4+                                                           +                                                           +  20
 ....
-20+  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 -90   -80   -70   -60   -50   -40   -30   -20   -10    -0     0    10    20    30    40    50    60    70    80    90   100
```

TARGET	TIME DELAY	DISTRIBUTION OF LOCALIZATION GIVEN DETECTION (1 Sigma SPA Radius)									
		.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5 NM
13	0	0.837	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1	0.490	0.816	0.857	0.918	0.918	0.939	0.939	0.959	0.980	0.980
13	2	0.224	0.388	0.449	0.531	0.551	0.571	0.592	0.694	0.714	0.776
13	3	0.163	0.306	0.327	0.327	0.408	0.429	0.469	0.490	0.551	0.551
13	4	0.122	0.204	0.245	0.286	0.286	0.347	0.367	0.367	0.408	0.408
13	5	0.020	0.041	0.041	0.041	0.041	0.061	0.061	0.082	0.082	0.102
13	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AVERAGE OVER THESE FLOWS		0.232	0.344	0.365	0.388	0.401	0.418	0.429	0.449	0.467	0.477
AVERAGE OVER ALL FLOWS		0.232	0.344	0.365	0.388	0.401	0.418	0.429	0.449	0.467	0.477

MARKED ON MON, MAR 03 1980 AT 21HR 12MIN 8.12SEC D.H.WAGNER ASSOCIATES SCREEN PROGRAM VERSION 3

LOCALIZATION MAP



An interesting thing to note about these pictures is the effect of the search on the target prior. This can be seen quite dramatically at time step 8. By comparing the posterior map to the prior map, we see that search cuts a swath through the posterior distribution in the region of the convergence zones. The localization map shows that the target is generally well localized by the time it arrives at the attack position. Otherwise, the localization is good in the vicinity of the flanking SSN escort.

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